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MANAGEMENT OF POULTRY MANURE AND ENVIRONMENTAL POLLUTION IN ANAMBRA AND IMO STATES OF NIGERIA

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ABSTRACT

The study examined the management of poultry manure and environmental pollution in Anambra and Imo States of Nigeria. The study was aimed at establishing that poultry manure is more an asset than pollution due to its beneficial usage. The broad objective was to examine the correlation between management of poultry manure and environmental pollution. The specific objectives of the study were to; examine how the management of poultry litter manure contributes to environmental pollution; the extent of relationship between the management of poultry cage manure and environmental pollution. Two research questions and hypotheses were formulated in line with the objectives of the study. The study was anchored on Holdgate pollution pathway theory and supported by Peter Drucker's theory of the business. The study adopted a descriptive survey design. The area of study was Anambra and Imo States respectively and a sample size of 205. The structured questionnaire was the main instrument for data collection and it was validated by experts. The test-retest method was used for reliability and the Cronbach Alpha using SPSS, 2.0 was used to establish the R value as 0.815(81.5%) for the test of the instrument. The simple mean score, and the linear regression analysis was used to analyze and test the hypotheses. The findings of the study revealed that; there were more males (146) representing 71% in the poultry business than females (59)=29%. Their ages represent the active working population of the states (41&above)=123 (60%), (36-40)=65 (31.7%), 26-35)= 16 (7.8%) and (18-25)=1 (0.5%), their marital status showed 169(82%) married, 34 (17%) single and 2 (1%) divorced. There is a positive significant relationship between the management of poultry litter manure and environmental pollution with coefficient value of 0.139, Tvalue of -2.004 and Pvalue of 0.046; there is no positive significant relationship between the management

of poultry cage manure and environmental pollution with a coefficient value of -0.104, T -1.497 and Pvalue of 0.046. The study concluded that, inadequate manure management leads to economic loss and increase in environmental concerns.

Key Words: management, poultry management practices, poultry manure, pollution, environmental pollution, deep litter, cage litter and waste management.

INTRODUCTION

The poultry sector, which occupies an important place in terms of food safety and nutrition, is the fastest growing agricultural sub-sector worldwide (Carvalho, Shimokomaki and Estevez, 2017). Nigeria is not left out in the growth process of the poultry sub sector. Nigeria currently has the largest annual egg production and second largest chicken production in Africa. Yet, it only meets 30% of the demand for chicken eggs and meat giving a huge possibility of expansion (Horrero, 2020). Poultry farming has become a lucrative business, contributing 27% of the national meat production, creating employment with good opportunities to earn a living, and it is well positioned to accomplish the UN's sustainable developmental goals of poverty eradication (FAO, 2020).

But, the use of large facilities associated with intensification and higher concentrations of poultry, has given rise to heaps of manure either in the litter or in the cage forms raising environmental concerns that are not only limited to the local production settings such as odour, flies, rodents and landscape degradation etc., but extend to the regional and national levels (Gerber, Opio and Steinfeld, 2006; Meheshwari, 2013). This nuisance is said to pollute the air, soil and water with nutrients, pathogens and heavy metals by the emissions from poor manure management and storage (FAO, 2019; Meheshwari, 2013). Is manure then a pollution agent or an asset?

In the wake of the global problem with climate change which has recently brought about COP 26 held in Glasgow and COP 27 held in Egypt, the slightest issue with pollution is taken very seriously as a precautionary measure to save the world. Yet this measure seems to be looking at the wrong direction for solutions. The matter with the pollution generated from the Russia-Ukrainian war and its consequent higher food prices, other industrial pollutions and the heaping loads of municipal wastes are not adequately addressed, yet agriculture is held as a global pollutant. This seems to be a direct attack on food security and on the feeding and sustenance of the teaming human population.

It is true that agricultural activities impact on the environment through the stages of its growth, and in the use of pesticides and fertilizers, as Behara, Sharma, Aneja and Balasubramanian, (2013) show that agriculture is the largest emitters of ammonia and Karimi, (2019) points out that ammonia while coming from birds hurt the birds and it is the hazardous gas that hurts the environment. Yet the beneficial aspect of ammonia is neglected. Could this accusation be coming from the contribution of Nitrogen to explosives? (seen in the case of Lebanon seaport explosion; 4th August, 2022). Ammonia is present everywhere in nature. Agriculture and indeed poultry farming is rather a victim and not a contributor to environmental pollution and climate change (Hegener, 2000; FAO and IAEA, 2021).

Concerning the pollution causing global warming and climate change, agriculture has been shown to occupy only 10% in the global chart of greenhouse gas release (Folnovic, 2015; USDA, 2021) because of the emission of ammonia. Yet on that chart, poultry as part of agriculture generates a very insignificant amount (Tabler, Khaitsa, Wells and Moon, 2020). Kaye (2020) in collaboration with the United States Environmental Protection Agency is specific that agriculture generates only 6.9% of greenhouse gasses and the poultry sector generates only a small fraction of 0.6% as compared to beef cattle 37% and dairy cattle 11.5%. It then follows that, the poultry industry has a natural advantage over other livestock industries because of its low carbon footprint and global warming potential (Costa, 2009).

Poultry meat and egg production is the most economic and environmentally efficient animal protein production system (Mengesha, 2011). And just like most agricultural wastes, poultry wastes are classified as organic wastes, which can be solid or liquid and they fall under the umbrella of biodegradable materials and are recyclable. Poultry manure contains all the essential plant nutrients and should not be regarded as wastes products rather as by products because of its varied beneficial usage (Amanullah, Sekar, and Muthukrishnan, 2020). Management and storage of manure has improved tremendously, that is why poultry houses is managed to dissipate heat and harmful gases to provide good environment to the bids and humans.

Hence, the study aims at establishing that proper management of poultry manure is important for a sustainable and livable environment and maintain standard efficiencies because, poultry manure management is the resource recovery practices whereby wastes are recycled to by products and become both economical and environment friendly. To this regard, the poultry manure management is examined to ascertain its place in environmental sustainability and not pollution.

CONCEPTUAL FRAMEWORK

Management

The term "management" connotes the process of dealing with, or controlling resources and people. It is the process of doing things in an organization or the administration of an organization. The term is a universal phenomenon and it is a widely used term. All organizations, be it business, political, cultural or social etc are involved in management because it helps and direct the various efforts towards a definite purpose (Juneja, 2022). Management is a vital aspect of the economic life of man/woman, which provides leadership (Das and Mishra, 2019).

Ngige (2008) points out that management can be looked at from many perspectives such as, an activity, "a collective noun, referring to a group of people within an organization" or "a process of performing certain specific functions to run the organization." This simply shows that management and organization go together. It shows at the same time that, management has been defined in various ways: as an activity, as a process, and as people etc. (Ngige, 2008; Das and Mishra, 2019; Juneja, 2022) As an activity, it is **a purposive activity** that directs group efforts towards the attainment of certain pre-determined goals (Juneja, 2022). This purposive activity includes; **Informational activities, Decisional activities, and Inter-personal activities.**

Management as people/group refers to all those persons who perform the task of managing an enterprise. This may include all managers from chief executive to the first line managers (lower-level managers) who enjoy the authority of making important decisions on the use of resources to accomplish organizational objectives. This implies that, management as people can further be broken into top level management, middle level management and lower level management (Juneja, 2022).

As a process, management refers to a series of inter-related functions. It is the process by which management creates, operates and directs purposive organization through systematic, coordinated and co-operated human efforts. As a process, management consists of three aspects namely, social process, integrating process and continuous process, which involves working with and through individuals or groups to accomplish organizational goals. This implies that, management is working in and through human relationships (Ngige, 2008).

For Peter F Drucker, "management is a multipurpose organ that manages a business and manages managers and manages worker and work" (Classic Drucker, 2006). In other words, it is people at the top who are held accountable for the success or failure of the organization (Ngige, 2008; Classic Drucker, 2006). These people are called managers. And they perform managerial activities by performing the functions of planning, organizing, directing and control. Functions of management simply tell what managers do in an organization. These functions are common to all managers irrespective of the status. Since management occupies an important place in the modern world, it influences the welfare of people and the destiny of a country (Das and Mishraa, 2019).

Managers run the organization within an organizational environment and hence, environmental analysis is needed to boost performance and remain competitive. Environmental analysis allows the organization to conform itself with what the environment demands through its perceived properties and components. (SWOT) Strengths, Weakness, Opportunities and Threats and (PEST) the political, economic, social, technological, legal and environmental are common tools for environmental analysis (Ngige, 2008). On the basis of this, the success of every business organizations including the poultry business anchors on best use of management practices.

Poultry

The term ‘poultry’ means any live or slaughtered domesticated bird (chickens, turkeys, ducks, geese, or guineas), and the term ‘poultry product’ means any poultry which has been slaughtered for human food, from which the blood, feathers, feet, head, and viscera have been removed in accordance with rules and regulations promulgated by the Secretary of Agriculture, or any edible part of poultry, or, unless exempted by the Secretary, any human food product consisting of any edible part of poultry, separately, or in combination with other ingredients (Featherstone, 2015). The term “poultry” covers a wide range of birds, from indigenous and commercial breeds of chickens to Muscovy ducks, mallard ducks, turkeys, guinea fowl, geese, quail, pigeons, ostriches and pheasants (FAO, 2021).

The etymology of the word "poultry" comes from the French/Norman word *poule*, itself derived from the Latin word *pullus*, which means small animal. The word "poultry" also comes from the West & English "pultrie", from Old French *pouletrie*, from *pouletier*, poultry dealer, from *poulet*, pullet. The word "pullet" itself comes from Middle English *pulet*, from Old French *polet*, both from Latin *pullus*, a young fowl, young animal or chicken. The word "fowl" is of Germanic

origin (cf. Old English *Fugol*, German *Vogel*, Danish *Fugl*) (American Heritage Dictionary of the English Language, Fifth Edition, 2016).

The term includes birds that are members of the "Super-order Galloanserae (fowl)", especially the order "Galliformes" (which includes chickens, quails, and turkeys) killed for their meat, but does not include similar wild birds hunted for sport or food as game. "Poultry" is a term used traditionally to refer to wildfowl (Galliformes) and waterfowl (Anseriformes) which excludes cage birds such as songbirds and parrot, In colloquial speech, the term "fowl" is often used nearly synonymously with "domesticated chicken" (*Gallus gallus*), or with "poultry" or even just "bird", and many languages do not distinguish between "poultry" and "fowl". Both words are also used for the flesh of these birds (Lie-Nielsen, 2017).

The domestication of poultry took place around 5,400 years ago in South-East Asia. Domesticated chickens may have been used for cockfighting at first and quail kept for their songs, but soon it was realized how useful it was having a captive-bred source of food. Selective breeding for fast growth, egg-laying ability, conformation, plumage and docility took place over the centuries, and modern breeds often look very different from their wild ancestors (Prabakaran, 2003; 2018; Killgrove, 2021).

The various species of fowls can be classified into three main groups: Egg producers; for example, white leghorn, brown leghorn, meat producers (broilers) example, Sussex, Cornish and Cochin. And the dual purpose birds that produce eggs and meat example, Rhode Island Red, Plymouth Rock and New Hampshire, as well as using their incidental by products such as faecal droppings and feathers in industries as natural unprocessed materials. Poultry are farmed in great numbers with chickens being the most numerous (Iwena, 2012; Stiles, 2017). Poultry meat and eggs provide nutritionally beneficial food containing protein of high quality (Wahyono and Utami, 2018).

Development of the poultry sector in Nigeria

Agriculture is a major economic preoccupation in Nigeria. Agriculture accounts for 35% of Nigeria's GDP. The Nigerian Poultry sub-sector contributes about 25% of the total livestock and fisheries contribution to the national GDP. The poultry sub-sector employs about 14 million Nigerians in direct and indirect employment. Yet, local production only meets 30% of the demand for chicken eggs and meat leaving a huge scope for the industry to expand (Herrero,

2020; Netherlands Enterprise Agency, 2020). Over 70 percent of Nigerians directly or indirectly derive livelihoods from the poultry industry (FAO, 2019).

The Nigerian poultry industry has a long history. Commercial poultry farms sprang up in Nigeria in the early post-independence years. Though, a few modern farms existed before Nigeria gained independence. In the oil boom days, Nigeria witnessed an expansion of her poultry and dairy industries, but this progress was reversed during the economic depression of the 1980s. After the restoration of democracy in 1999, a new wave of renewed efforts to develop agriculture (including poultry) began in Nigeria. One of the major incentives for growth was the ban on importation of poultry products (Netherlands Enterprise Agency, 2020).

From 2005, several intervention agencies and funds for the development of agriculture were introduced. Among them are the Commercial Agriculture Credit Scheme (CACS), which enabled many of the leading commercial poultry producers to expand dramatically from 2008 to 2013. The Nigeria Incentive Based Risk Sharing Scheme for Agricultural Lending (NIRSAL) was to de-risk agricultural lending and make commercial banks more willing to lend to the agricultural sector. The NIRSAL scheme was particularly helpful to the poultry sector because the bird flu scares of 2005, 2006 and 2009 heightened the perception of risks associated with the poultry business, thereby discouraging banks from lending to poultry farmers (Netherlands Enterprise Agency, 2020).

Against this background, in 2015, the Nigerian political leadership expressed the desire to reduce importation and promote local production. The government further strengthened the enforcement of the ban on smuggling. With improved control of smuggling, broiler farmers were able to penetrate the market and expand their production. The government also strengthened the Anchor Borrowers Programme, which enabled small and medium scale farmers to participate in agricultural lending schemes by being linked to off-takers whose guarantee enables small farmers to access funding (Netherlands Enterprise Agency, 2020).

The Federal Ministry of Agriculture and Rural Development is the main organ of the government responsible for overseeing the poultry industry in Nigeria. The poultry industry is mainly private sector driven, with sizeable numbers of players across the various categories. In the past few years, the private sector has been growing rapidly in terms of diversity, maturity and the number of players setting up to provide very specific products and or services, for example; branded eggs and chickens, breeding, feed, vaccines, machinery, etc. The more the sector develops, the more

businesses will increase in specialization to ensure that they serve a specific niche in the market (Netherlands Enterprise Agency, 2020).

Nigeria has the second largest chicken population in Africa after South Africa. The poultry sector contributes 6-8% of the GDP, which is about 30% of the total agriculture contribution. Over 13 million households keep livestock at their homes and receive (at least part of) their income from it. (Udoh, 2020; Netherlands Enterprise Agency, 2020). The Nigerian poultry sector is pivotally positioned to stimulate an Africa wide industry development and growth given its share size and experience (Udoh, 2020). This is in unison with the United Nation's Sustainable Development Goals on the poverty eradication scheme (UNSDG 2016).

Nigeria's poultry production has grown steadily despite the myriad of challenges facing it. Dealing with these challenges can lead to a faster expansion of the Nigerian poultry market (Netherlands Enterprise Agency, 2020). However, Nigeria still has a long way to go although production and consumption levels have been increasing. This means that opportunities still abound for increased and improved production and consumption of poultry products in the country (Ajala, Ogunjimi, Famuwaguu, and Adebimpe, 2020).

Poultry management practices: Poultry management refers to the production techniques that optimize the efficiency of production and profitability. These practices range from housing management to waste management.

Housing management: The system of housing management defines the extent to which, birds are exposed to sunshine, pasture and also housing pattern. Improvements to poultry housing systems in developing countries like Nigeria have focused on providing an environment that satisfies the birds' thermal requirements. Production is carried out in the small scale, medium or the large scale (Glatz and Rym, 2003). There are three systems of poultry housing management; these are the extensive, semi-intensive and intensive systems (Erebor 2003; Moyle, 2011; Iwena 2012). These systems are the options open for entrepreneurial opportunities. All three systems generate significant amount of poultry manure.

The Extensive system: Under this production system, the domestic fowls are allowed to roam about in search of food and water. Flocks contain birds of different species and varying ages. There may be rudimentary shelters, though most birds roost outside in trees and nest in the bushes. There is no proper housing, care and feeding for these birds. Production is subsistence

oriented, mainly for family consumption. This system is present mainly in the northern regions of the country (FAO, 2019). The investment is small and the bird's population per hectare of land is minimal and production is usually very low. The use of technology is also limited (Iwena 2012). Erebor (2003) holds that the extensive system is sub divided into two forms namely; the fold system and the free range system.

The fold system is ideal for chick rearing and also for transporting birds from the pen to the market. Traders rely on the fold system before disposing of their birds. A fold may be made with a basket or other movable housing units. About 50 to 100 birds are kept inside the basket with feeding and watering troughs supplied to the birds. The fold is mobile and can be moved from one point to another (Erebor (2003).

The free range system allows free access to a range of grassland (Erebor (2003). The birds are allowed to run freely over a large fenced area where they experience natural conditions. The birds are confined in a hut or a shed at night and are allowed to roam within the fenced area during the day (Iwena 2012). This is one of the oldest on earth. It is mostly practiced by the subsistence farmers.

The Semi-Intensive system: The semi intensive system is a mid way between intensive and extensive systems. The birds are housed in a fixed building but are allowed to move about within a fenced area during the day. Their buildings are made up of wood and are raised above the ground with wire netting on the floor to permit easy dropping of feces (Iwena 2012). The system involves the keeping of birds in a solid building which serves as a noonday protection from harsh weather like rain and sunshine and sometimes for egg laying. The flock size is usually between 50 – 2, 000 birds, including both improved and unimproved breeds. It is a small-scale business based on family labour and locally available feed resources, often complementary to other farming activities. Semi intensive poultry farms are mainly located in the southern regions of the country (FAO, 2019).

The Intensive system: Under this system, farmers keep more than 2 000 exotic birds of one species, producing either meat or eggs for the market. The system ranges from medium to large scale commercial enterprises and high premium is given to stock breed, feeding, housing and health services. The more advanced integrated holdings use automated chain feeding and watering systems. This system is dominant in the southern regions of the country (FAO, 2019). The birds are confined within the building and are not allowed to move out. It prevents the birds

from having access to pasture and sunshine. There is high stocking density which implies a closer contact among the birds. Feeds, water and all medications are provided for the birds. The system is practiced in two modes namely, the deep litter system and the cage system (Iwena 2012; Erebor 2003).

1) **The Deep litter System:** The deep litter system involves the keeping of both male and female birds together on the floor of the house which must be concrete and covered with straws, dried grasses or wood shavings which absorb the water associated with feces. The roof is made of iron sheets or asbestos. Birds are provided with all their needs in terms of water and feeds (Erebor, 2003). For the National Chicken Council (2012), meat chickens, commonly called broilers, are floor-raised on litter, indoors in climate-controlled housing. Broilers are not raised in cages. They are raised in large, open structures known as grow out houses.
2) **The Cage System:** In the cage system, birds are housed in individual cages each accommodating a limited number of birds, mostly one or two. This individual cage compartment is the basic component unit of the cage system and it is essentially a laying nest with a sloping floor and feed and water troughs (Iwena, 2012). It is constructed to permit ventilation from all sides. Usually the sides, top and floor are constructed with heavy galvanized iron. The floor is sloped with wire mesh to allow the feaces to drop through and eggs to roll onto an egg-collecting conveyor belt. Water is usually provided by overhead nipple systems, and food in a trough along the front of the cage replenished at regular intervals by a mechanical chain. The cages vary in their degree of automation. The poultry droppings fall into a pit (a shallow duct) and are cleaned off with a mechanical scrapper. Under skilled management, the battery system of housing has proved to be the best with regard to egg production, efficiency of food conservation and reduction in mortality (Iwena, 2012).

Other management aspects in poultry production include; incubation and hatching, slaughtering, processing and packaging, (Farinde (2015). Slaughtering to packaging is very sensitive as it involves handling live birds. In between the process, scalding, defeathering, eviscerating, washing and chilling occur (Da Silva, 2013; Nicol, 2013). Feed management shows that feed is the most important input in poultry production, accounting for over 70% of the total cost of production. This comes in three forms namely, crumbles, pellets and mash. The different stages

of development in feeding include chicks, growers, and layers (Mormino, 2020; Smith, 2020) not ignoring the lighting program (Stokvis (2020).

Poultry Manure

Poultry manure/chicken manure is the organic waste from the poultry farm which is composed of feces and urine of chickens. It is a mixture of spilled feed, feathers and bedding materials rich in plant nutrients (Jagdish, 2020). Poultry manure is simply the feces of birds used as organic fertilizer. Poultry manure and litter are often used interchangeably (Jagdish, 2020) yet there is a whole lot of differences between them. The two main types of manure produced by poultry production are poultry litter (waste from deep litter systems) and cage layer waste (excreta collected under the cages, spilled feed and feathers), simply referred to as wet and dry wastes (Thomas, Jayalalitha, and Jagatheesan, 2020). Moreki and Chiripasi (2011) estimated daily manure production by a broiler and laying hen to be 0.09 kg and 0.18 kg, respectively.

Poultry manure contains naturally occurring micro organisms many of which are environmentally beneficial and play important roles in the ecological nutrient cycle, yet some can be harmful to humans and environment. (William, 2013; Thomas, Jayalalitha, and Jagatheesan, 2020). Poultry manure contains all the essential plant nutrients need for growth (William, 2013; Amanullah, Sekar and Muthukrishnan, 2010). Good manure management should include consideration for bio-security, preventing contact with birds and other scavenging animals. Poultry manure has no adverse effect on the environment. It is rather beneficial in all ramifications, yet improper management can cause pollution

The two main types of manure arise from the two methods in housing; deep litter floor raised system and cage raised system. This can also be distinguished as simply the wet and dry manure.

Deep litter: Deep litter is a housing system in which the floor is covered with wood shavings such as: straw, sawdust, rice hulls, and peanut hulls etc. for bedding. This bedding material is what is called litter (Mbazu, 2022). Either broilers or layers can be housed in the deep litter system. Hence, it is a system in which a number of hens (birds) are housed in one covered enclosure within which they can move freely, on a layer of straw or wood shavings several centimeters deep. Litter is the dropping along with bedding material (Singh, 2020; Jagdish, 2020).

For Mormino, (2022) “deep litter is a method of chicken waste management that calls for dropping and bedding material to compost inside the chicken loop instead of being cleaned out and replaced regularly”. Poultry produces feces throughout the production cycle, which have high water content that must be absorbed. One of the advantages of the deep litter system is that, it absorbs moisture from the chicken feces/dropping. With this, managing the housing is made efficient and effective. Conversely, the disadvantage of the deep litter system is that, ticks, lice, bacteria (parasites) easily live in the litter as a result of poor management of litter. Litter management is important in poultry farming because, it can lead to the improvement of bird performance and welfare (Saenez, 2021).

The quantity of bedding (litter) materials depends on the size of the poultry specie, age, diet and health of the birds. The quantity of excrement to be managed depends on factors such as water content, whether it is stored in a location where rainfall collects or whether it is mixed with bedding materials such as straw, wood shavings or rice hulls. Manure and litter storage conditions may influence some nutrient concentration. Ammonia may be lost when exposed to rain or groundwater (William, 2013).

The Cage System: In the cage system, birds are housed in individual cages each accommodating a limited number of birds, mostly one or two. This individual cage compartment is the basic component unit of the cage system and it is essentially a laying nest with a sloping floor and feed and water troughs. It is constructed to permit ventilation from all sides. Usually the sides, top and floor are constructed with heavy galvanized iron. The floor is sloped with wire mesh to allow the feces to drop through and eggs to roll onto an egg-collecting conveyor belt. Water is usually provided by overhead nipple systems, and food in a trough along the front of the cage replenished at regular intervals by a mechanical chain (Iwena, 2012).

The cages vary in their degree of automation. On the one hand, all operations may have to be performed manually, while at the other extreme, practically all the various operations including manure removal may be automated. The poultry droppings fall into a pit (a shallow duct) and are cleaned off with a mechanical scrapper. Under skilled management, the battery system of housing has proved to be the best with regard to egg production, efficiency of food conservation and reduction in mortality (Iwena, 2012).

Poultry waste management

Waste management is the activities and actions required to manage waste from its inception to its final disposal. This includes the collection, transport, treatment and disposal of waste together with monitoring and regulation of the waste management process. Poultry waste includes a mixture of bird excrement and urinary excreta (manure), bedding material or litter (wood shavings, straw, saw dusts, peanut and rice hulls), waste feed, dead birds, broken eggs, packing material and feathers removed from poultry houses. It also includes waste from cage, conveyer belt and water flushing systems Thyagarajan, Barathi, and Sakthivadivu (2013). Just like most agricultural wastes, poultry wastes are classified as organic wastes, which can be solid or liquid and they fall under the umbrella of biodegradable materials.

A proper disposal of poultry wastes plays an important role in the control and eradication of diseases. Without proper waste management, poultry production constitutes risk for the consumers and the producing systems. This affects the handling of live birds because from it, viruses may spread (FAO, 2013). Poultry wastes can be disposed in shallow ponds where fermentation would take place or simply disposed as heap, spread or in pits (Sheikh, 2012). Ogundiran, Ademola and Adejumo (2015) show that poultry litter can be treated and reused or applied to the soil. Poultry wastes can also serve as byproducts for other industries.

Pollution

When poultry wastes are not properly disposed, they cause pollution. The term “pollution”, is from the Latin word “polluere/pollutio” meaning ‘to soil, defile or contaminate’ (Dictionary.com, 2021). According to Section 1(3) of the U.K. Environment Protection Act, 1990, the term “Pollution” means the release (into any environmental medium) from any process of substances which are capable of causing harm to man or any other living organisms supported by the environment. Thus, substances that cause hazards to human health, living resources and ecological systems, damage to structure or amenity or interference with legitimate uses of the environment is pollution (Appannagari, 2017; Berg, 2017).

Pollution occurs when there is the potential for harm. Harm here is not confined to physical injury but encompasses offence caused to any of the senses or harm to property, therefore smells and noise which may not cause injury can constitute pollution. (Nabegu and Naibbi, 2016; Appannagari, 2017; Bradford, 2018). Smell is the point at which poultry production can cause

pollution. Pollution occurs in two forms namely: the natural and artificial or (Man-made) forms. The natural produced naturally through means such as volcanic eruption, earthquakes, forest fires, dust storms, bacteria, spores, cysts, pollen and decay of organic matter while the artificial is through industrialization, over population, deforestation, nuclear explosion, mining and quarry, over exploitation of natural resources, construction, and use of fertilizers etc. (Mondal, 2021; UK Essays, 2018), and they have huge effects on the environment.

In the same vein, there are two types of pollutants viz; primary and secondary pollutants. Primary pollutants exert harmful effects in the form in which they enter the environment such as fossil fuel consumption, volcanic eruption and factories (Narwaria, 2020). Secondary pollutants are synthesized as a result of chemical processes, often from less harmful precursors in the environment. A secondary pollutant is not directly emitted as such, but forms when other pollutants (primary pollutants) react in the atmosphere.

Three factors determine the severity of a pollutant: its chemical nature, the concentration on the area affected and the persistence. Some pollutants are beneficial like phosphates and other plant nutrients essential to aquatic life, yet too much of it results in eutrophication. In the same vein, pollutants, like dioxin and P.C.B.s, are so toxic that even the minutest amount poses health hazards, such as cancer and reproductive impairment (Nabegu and Naibbi, 2016).

Dispersal of Environmental Pollution: There are two different means of pollution dispersal namely: Point Source Pollution and Non-point Source Pollution. Each slightly affects the environment differently. The term "point source" means any discernible, confined and discrete conveyance, from which pollutants are or may be discharged. This term does not include agricultural storm water discharges and return flows from irrigated agriculture. The term "nonpoint source" is defined to mean any source of water pollution that does not meet the legal definition of "point source" in section 502(14) of the Clean Water Act (EPA2021). It is the type of pollution that cannot be easily tracked back to its source. Common non-point sources are agriculture, forestry, urban, mining, construction, dams, channels, land disposal, saltwater intrusion, and city streets.

Environmental pollution: Pollution is the most serious of all environmental problems and poses a major threat to the health and well being of millions of people and the global ecosystem (Jan, Rashid, Azooz, Hossain and Ahmad, 2016). Landrigan and Fuller, (2018) assert that, in 2015, pollution was responsible for 9 million premature deaths; which is three times as many deaths as

caused by AIDS, tuberculosis and malaria combined. 92% of PRD (pollution related disease) occurs in low and middle income countries, and in hardest hit countries. Pollution and climate change are closely linked, because both arise from the same sources, and both can be controlled by similar solutions.

In Nigeria, environmental issues did not gain official prominence until the 1988 Koko toxic waste dumping saga. The result was the formulation of a national policy on the environment, to tackle environmentally related issues, in the country. This gave birth to the Federal Environmental Protection Agency (FEPA) charged with the administration and enforcement of environmental laws. In addition, the government enacted the Harmful Waste (Special Criminal Provisions) Act, 1988, to deal specifically with illegal dumping of harmful wastes (Ogbodo, 2009).

Under this situation, the Nigeria Federal Environmental protection Agency (FEPA) Act of 1990, under section 38 gives a very lucid definition of environment, thus; Environment includes water, air, land and all plants and human beings and/or animals living there in and the interrelationships which exist among these or any of them (Ogbodo, 2009). With this definition, it becomes imperative to treat environmental pollution under the categories of air, water and land.

There are many types of environmental pollution, but the most important ones are: Air, water and land pollution (Folnovic, 2020; Nawaria, 2020). Air pollution refers to the release of detrimental pollutants into the air. These are most often emitted during gas or coal combustion, incinerating, or found in gasoline (Manisalidis, et.al., 2020; Mackenzie and Turrentine, 2021). Water pollution happens when chemicals or dangerous foreign substances are introduced to water, including chemicals, sewage, pesticides and fertilizers from agricultural runoff, or metals like lead or mercury (Bradford, 2018; Denchak, 2018; Narwaria, 2020).

Soil pollution can be natural or due to human activity. Soil contamination or soil pollution as part of land degradation is caused by the presence of xenobiotic chemicals or other alteration in the natural soil environment. It occurs when the pollutants causing the pollution make the soil inhabitable for microorganisms and macro organisms living in the soil (Narwaria, 2020; Shaltami, Hamed, Fares, Errishi, and Maceda, 2020).

Management of Poultry Deep Litter Manure Production and Environmental Pollution

The quantity of poultry litter produced in a broiler unit depends on the litter management, and feed intake and its digestibility. Three common practices are adopted for litter management in broiler units: single use litter, partial re-use and multi-use litter (Singh, 2020; Barnrie, 2012). The single-use litter involves the total clean-out of the house after each flock cycle and replacement of the bedding material. Partial re-use involves the removal of litter from the brooding section for spreading on the grower section of the house. New bedding material is then spread on the brooding section. The partially spent litter is often composted for a few days to elevate its temperature to kill pathogens. Some of the spent litter may be removed after each batch, and after 2 to 5 batches the house is totally cleaned out (Bolan et.al., 2010).

With the multi-use of litter, only caked material is removed and the house is disinfected. The litter in the brooding section is either left untouched or covered with 25 to 50 mm of fresh bedding material. The multi-use litter may increase the incidence of pathogenic microbes and parasites, and produces a spent litter with a much higher concentration of nutrients. Handling and storage affect the actual quantity and quality of manure generated from poultry units (Bolan, et.al., 2010).

Waste production from poultry houses have always been an issue with regards environmental pollution, human health and quality of life of the people living around the poultry farms (William, 2013). This concerns proper storage, handling management, utilization of by-products as a resource recovery strategy. Poultry growers have become sensitive to the potential nuisance of odors, insects and vermin, pathogenic micro organisms or run off that offends neighbours (William, 2013). This critical consideration makes for long term and sustainability of poultry production.

To avoid pollution within the poultry house and its environment, the quality of the litter must be kept optimal. That is, always dry but not too dry as to cause dust. Litter condition affects bird performance, so it must be kept dry in order to control smell and ammonia (Barnrie, 2022; Agara, 2022). Good ventilation also helps in the control of smell and humidity. This is why poultry houses are built with open sides or fan managed.

However, there is no way water will not touch the litter, because the dropping is mixed with urine, and water from the drinkers sometimes fall on the litter. Once this happens, the litter

begins to mould (cake). To prevent caking, the litter materials should be stirred or raked at least twice a week (Singh, 2020). To reduce ammonia in the litter, the litter amendment can be done by applying acidifier to the litter. Windrowing which is a deep stacking of the litter for partial composting is another method. This can eliminate harmful pathogens from the litter. Once it is dry, the litter can be reused otherwise, outright disposal can be practiced.

At this point, the resource recovery becomes handy whereby the litter is converted to byproducts for other industries. For example:

Application to arable lands as fertilizer: Continuous cultivation of arable soils results in the deterioration of the soil structure leading to reduced crop yield. Poultry manure has been recognized as the most desirable of all animal manures (fertilizers) because of its high nitrogen content. Poultry manure has high crop nutrient content and they are easy to handle and use as fertilizers. The major plant nutrients in poultry manure include N,P,K, calcium (Ca), magnesium (Mg) and sulphur (S) (Bolan, et.al., 2010). As a result, direct land application of poultry litter from broiler operations is the most widely used and cost effective disposal method. For some poultry producing regions, the spreading of poultry waste has become less cost effective mainly because of restrictions on land availability (Moreki and Chiripasi, 2011). In Nigeria, poultry manure production is not enough for land spreading as fertilizer.

Application of poultry manure improves water holding capacity of soil and increases lateral water movement, therefore improving irrigation potentiality and decreasing the dryness of soils. It increases the number and diversity of soil microorganisms, particularly in sandy conditions. It is difficult to prescribe any uniform standard but care has to be taken to spread poultry manure thinly on the soil instead of dumping in a heap. Since soil condition also varies widely it is difficult to prescribe any limit (Singh, Mondal, Sharma, Mahalakshmi, and Gupta, 2018).

The proper handling and management of manure can augment or replace purchased commercial fertilizers for farmers. Utilization of poultry waste as a source of manure for crop production has been the favored system for recycling nutrients. Manure can be applied directly to the soil or it can be pelleted before application. Pelleting manure converts a wet heterogeneous material which is difficult to apply on the land uniformly into a uniformed matter which is easy to handle and transport to areas where there are infertile soils to reduce the excess of nutrients in soils and water in poultry producing regions. Also, pelleting can allow for low quality manure to be fortified with inorganic fertilizers (Moreki and Chiripasi, 2011).

Poultry waste in livestock feeding: Poultry manure, either on its own or when mixed with feed grains, has been found to be a valuable feed diet for cattle, lactating cows, lambs, ewes, swine and fish. Ruminants are able to utilize the urea nitrogen (uric acid) in poultry manure (Bolan, et.al, 2010). In other words, poultry litter can be processed and recycled for the poultry industry and other livestock farms. When it is given to ruminants as feed, uric acid which is the major Non Protein Nitrogen (NPN) source in poultry is degraded to ammonia by rumen microbes (Moreki and Chiripasi, 2011; Singh, Mondal, Sharma, Mahalakshmi, and Gupta, 2018).

In Nigeria, Owen et al. (2008) investigated the nutrient quality of heat treated poultry litter and obtained dry matter (DM), crude protein, energy, crude fibre, ether extract and ash values of 87%, 20%, 621.41 kcal/kg, 10.40%, 2.2% and 18.50%, respectively. In addition, phosphorus, calcium, sodium, potassium and magnesium values in the litter were 4.50%, 2.00%, 0.10%, 2.05 and 0.48%, respectively. They concluded that poultry litter could be incorporated into animal feeds (Moreki and Chiripasi, 2011).

Conversion of poultry litter to energy: Poultry litter has been shown to be a viable, renewable biomass fuel. This conversion of poultry litter to energy furnace provides a high value alternative to land application and helps to control rising energy costs (Habetz and Echols, 2006). Anaerobic digestion and direct combustion are technologies that can be used to convert poultry waste material to energy. Methane gas produced during anaerobic digestion can be gas cleaned and used as a renewable energy in households for cooking and heating. Biogas production appears to be an attractive technology despite the high energy cost. Biogas has less odors and lower fly populations, as well as, reduces greenhouse gas emissions (Phanthavongs et al., 2011).

Heat and electricity can be generated from manure combustion as renewable sources of energy. Habetz and Echols (2006) noted that because of the controlled combustion process, the resultant ash is converted to a concentrated fertilizer or fertilizer amendment, high in phosphorous, potassium, calcium, magnesium and other valuable micronutrients. However, concerns have been raised due to the gas emission into the air. As a consequence, it is necessary that technologies such as gas cleaning are employed to reduce the impact of these emissions. Poultry litter can be burnt directly as a fuel source to produce heat energy. One of the problems with it is its high moisture content (Bolan, et.al., 2010).

Use of poultry litter for treatment of heavy metal contaminated water: Utilization of poultry litter as a precursor material to manufacture activated carbon for treating heavy metal

contaminated water is a value added strategy for recycling the organic waste (Guo et al., 2010). Poultry litter based activated carbon possesses a significantly higher absorption affinity and capacity for heavy metals than commercial activated carbons derived from bituminous coal and coconut shell and does not pose secondary water contamination risks. This may account for the reason why in the Western countries, commercial poultry farms dump their wastes in water bodies (Moreki and Chiripasi, 2011).

Management of Poultry Cage Manure Production and Environmental Pollution

As has been seen, in the cage system, birds are housed in cages accommodating a limited number of birds (Iwena, 2012). Even though broilers can be caged, cages are basically for layers. It is constructed with galvanized iron to permit ventilation from all sides. The floor is sloped with wire mesh to allow the feces to drop through and eggs to roll onto an egg-collecting conveyor belt. The poultry droppings fall directly into trays beneath the cages, or on conveyor belts, or on the floor or a pit (a shallow duct) under the cages and are cleaned off manually or with a mechanical scrapper. (Iwena, 2012).

The management of cage droppings can be in two forms namely; semi solid/solid and liquid form. Most droppings are mixed with urine, thus they are to be cleaned out daily or at least once in two days either by scrapping or by flushing with water to avoid smelling. The scrapped droppings are then processed by drying (using drying machine or just spread on the drying zone) after which they are stacked in bags for sale as fertilizer with high nitrogen, phosphorous and potassium for plants (Paul, 2022; Singh, et.al., 2018). According to Paul, (2022) the manure generated is sent to the northern part of Nigeria, yet what is generated is not enough. During the hot seasons, to control heat, the fogger system is put on but when the water touches on the droppings they begin to react and smell. With this, odour pollution is avoided.

For flushing, a duct/gutter is constructed to enable the droppings to be washed into a pit, septic tank or a pond, where it is treated and converted to fertilizers to be used as effluents. Some farmers pond the droppings either to rear maggots for fish farmers (the consequences of using maggots to rear fish is beyond the scope of this research). Others ferment or culture the droppings to grow algae or lilies. These algae are processed to extract Omega 3 (for drugs that contribute in the treatment of heart related ailments). The lilies are directly used as green feed for other ruminants. From the descriptions above, one notices that there are no harm to the environment, rather an enhancement of the environment.

Ammonia pollution from manure storage

Without proper management of manure, poultry facilities become a source of odour that attract flies, rodents and other pests that create local nuisances and carry disease. Odour emissions from poultry farms adversely affect the life of people living in the vicinity. Odour associated with poultry operations comes from fresh and decomposing wastes, and manure storage facilities (Gerber, Opio and Steinfeld, 2007). Odour is a local issue, is hardly quantifiable. Its impact depends on the perception of those living near the farm. However, odour problems are generally concentrated within 500 metres of the farm. This is why it is regulated that poultry houses be built at least 1km away from residential areas.

Though there has not been any public health concern, odour can represent a strong local problem that is frequently reported by farms' neighbours as the most disturbing environmental impact. The emission of odour mostly depends on the frequency of poultry house cleaning, on the temperature and humidity of the manure, on the type of manure storage, and on air movements. For these reasons odour is generally higher around the farms (Gerber, Opio and Steinfeld, 2007). A study by Harper, et.al. (2010) report that ammonia emissions were low at bird placemen and increased steadily after about the third week of growth. While Bai, et.al (2021) report that this can be dispersed up to 10km along wind direction.

Atmospheric ammonia (NH3) is increasingly being recognized as a major air pollutant because of its role in regional-scale tropospheric chemistry and its effects when deposited into the ecosystems. Ammonia is a soluble and reactive gas. This means that it dissolves, for example in water, and that it will react with other chemicals to form ammonia-containing compounds. The concentrations of ammonia in the air are greatest in areas where there is intensive livestock farming. Agricultural land receiving large inputs of nitrogen from manures normally acts as a source of ammonia, but it may also act as a "sink" and absorb ammonia from the atmosphere (Williams, 2013; Lidwien and Smith, 2017).

Importance of ammonia to nature

In the studies of Harper, et. al (2010); Bai, et.al. (2021) and Singh, (2019), they show that ammonia is a primary basic gas in the atmosphere and it has an important role in the neutralization of atmospheric acids generated by fossil fuel combustion. Ammonia reacts with other chemicals to form nitrous oxide as a particulate matter. Ammonia is a building block

chemical and a key component in the manufacture of many products people use every day. It occurs naturally throughout the environment in the air, soil and water and in plants and animals, including humans. The human body makes ammonia when the body breaks down foods containing protein into amino acids and ammonia, then converting the ammonia into urea. Ammonia is renewed naturally as part of the nitrogen cycle that already occurs as plants fertilizer. As a result of this natural process, ammonia does not last long in the environment, and it also does not bio-accumulate (Chemicalsafetyfacts.org, 2021).

Many human activities have a significant impact on the nitrogen cycle. Burning fossil fuels, application of nitrogen-based fertilizers, and other activities can dramatically increase the amount of biologically available nitrogen in an ecosystem. And because nitrogen availability often limits the primary productivity of many ecosystems, large changes in the availability of nitrogen can lead to severe alterations of the nitrogen cycle in both aquatic and terrestrial ecosystems. Industrial nitrogen fixation has increased exponentially since the 1940s, and human activity has doubled the amount of global nitrogen fixation (Benhard, 2010). Therefore, ammonia is beneficial in its uses as fertilizer for agricultural purposes, in households as cleaning agents, in industries as refrigerant to cool and absorb heat, to purify water, as explosives, pesticides or dyes and finally as wastewater treatment etc. (Chemicalsafetyfacts.org, 2021)

Ammonia and human health

The Agency for Toxic Substances and Disease Registry (ATSDR) states that, “no health effects have been found in humans exposed to typical environmental concentration of ammonia. Exposure to high levels of ammonia in air may be irritating to a person’s skin, eyes, throat, and lungs and cause coughing and burns. Medical tests can detect ammonia in blood or urine. But because ammonia occurs naturally in the environment, these test results are not considered effective biomarkers of exposure.

MATERIALS AND METHOD

The study was carried out in \Anambra and Imo States of Nigeria respectively. Anambra and Imo states are situated in the South-Eastern geopolitical zone of Nigeria. the populace are predominantly homogeneous black people with the Igbo language as the major spoken language. Both states are divided into three senatorial zones with 21 L.G.A each, they also have four agricultural zones each. The study made use of the descriptive survey design. The population for

the study was 4054 poultry farms. 2240 from Imo State and 1814 from Anambra Stat.364 sample size was determined with Slovin's formula.

The distributions between the states were 201 for Imo State, and 163 for Anambra State. A structured questionnaire following the likert format was used for data collection. However, for security challenges, the study only arrived at a total of 205 farms as follows; 115poultry farms from Imo State and 90poultry farms from Anambra State. The simple random sampling was used to select respondents to the study. The test retest method was used to determine reliability with the Cronbach Alpha reliability value of 0.815 (81.5%). The mean score and the simple linear regression was used for analysis and test of hypotheses. The study was anchored on the Holdgate pollution pathway theory and Peter Drucker's theory of the business.

RESULTS

The results of the study revealed that; there were more males (146) representing 71% in the poultry business than females (59)=29%. Their ages represent the active working population of the states (41&above)=123 (60%), (36-40)=65 (31.7%), 26-35)= 16 (7.8%) and (18-25)=1 (0.5%), their marital status showed 169(82%) married, 34 (17%) single and 2 (1%) divorced. There is a positive significant relationship between the management of poultry litter manure and environmental pollution with coefficient value of 0.139, T-value of -2.004 and P-value of 0.046; there is no positive significant relationship between the management of poultry cage manure and environmental pollution with a coefficient value of -0.104, T -1.497 and P-value of 0.046. The study concluded that, manure by itself does not cause pollution but inadequate manure management leads to economic loss and increase in environmental concerns.

CONCLUSION AND RECOMMENDATIONS

The study concluded that, poultry manure in itself is beneficial, has no adverse effect and does not cause pollution, but inadequate manure management leads to economic losses and an increase in environmental concerns. Adequate poultry manure management both in the litter and cage system ensures a comfortable breeding experience. At the end of a grow-out period, the manure has other uses and economic opportunities that are environment friendly.

The study recommended that since the poultry industry has come to stay with its beneficial contributions to both humans and the environment, farmers must continue to improve on the hygiene level in place in the farms and to see to it that, disease resistant birds be raised for a

more productive output. Also, since litter and dropping manure have gained economic value in the poultry industry, farmers, buyers and health officials must see to it that manure are properly handled to mitigate pollution by odour.

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APPENDIX 1

QUESTIONNAIRE

CHUKWUEMEKA ODUMEGWU OJUKWU UNIVERSITY
(DEPARTMENT OF BUSINESS ADMINISTRATION)

Instruction: Some of the questions contain response alternatives. You are requested to tick against the alternative(s) of your choice as thus, (√)

SECTION A

PERSONAL DATA

1) SEX: (a) Male ( ) (b) Female ( )
2) Age bracket: (a) 18 – 25 ( ) (b) 26 – 35 ( ) (c) 36 – 40 ( ) (d) 41 and above ( )
3) Marital status (a) Single ( ) (b) Married ( ) (c) Divorced ( )
4) Educational qualification: (a) GCE/WASCE ( ) (b) A Level/OND ( ) (c) BSc./BA/HND ( ) (d) MSc./MBA ( ) (d) PhD ( )

SECTION B

1) What lines of fowl birds do you rear? (a) Broilers ( ) (b) Cockerels ( ) (c) Layers ( ) (d) Native fowls ( ) (e) Combination of all ( )
2) What type of housing systems do you practice? (a) Litter ( ) (b) Cage ( ) (c) semi-free ( ) (d) Free range ( )
3) What are your lighting and heating systems (a) Electricity ( ) (b) Generator Petrol/Gasoline ( ) (c) Kerosene lamps ( ) (d) Charcoal/coal ( ) (e) Others ( )
4) Production output? (a) Normal ( ) (b) High ( ) (c) Low ( ) (d) Moderate ( )
5) Your specialized productions are: (a) Meat ( ) (b) Eggs ( ) (c) Combination of meat and eggs ( )
6) Types of production (a) Hatch & Sell ( ) (b) Brood & Sell ( ) (c) Lay & Sell ( )
7) Production management (a) Small Scale ( ) (b) Medium Scale ( ) (c) Large Scale ( )
8) Mortality rate (a) 10 – 20% ( ) (b) 30 – 40% ( ) (c) 40 – 50% ( ) (d) Above 50% ( )
9) Age of the farm (a) 1 – 3yrs ( ) (b) 4 – 6yrs ( ) (c) 7 – 10yrs ( ) (d) Above 10yrs ( )
10) Number of birds in their various levels: Broilers ( ) Layers ( ) Cockerel (

SECTION C

Items	SA	A	UD	D	SD
Litter manure					
The litter from the poultry house is cleaned out regularly					
The Poultry litter are treated for odour					

reduction and ammonia sterilization					
Residents around the farm complain about foul smell					
You listen to the complaints of residents around the farm					
Rats, snakes, insects and worms infest the farm area					
Poultry litter wastes are dumped into available water body like gutter, river, canal or lake?					
You stack and store up your litter waste products as byproducts					
You practice the waste hierarchy (reduce, reuse and recycle)					
The used litter from production are burnt with fire					
Used litter are thrown away in dustbins/land fills					
Used litter are decompose by composting for agricultural purposes					
You sell and have customers to buy up your litter waste products as byproducts					
Bird Droppings					
The droppings from the poultry house is cleaned out regularly					
The Poultry dropping are treated for odour reduction and ammonia sterilization					
Residents around the farm complain about foul smell					
You listen to the complaints of residents around the farm					
Rats, snakes, insects and worms infest the farm area					
There is so much foul smell from the droppings					
Poultry dropping wastes are dumped into available water body like gutter, river, canal or lake?					
You stack and store up your dropping waste products as byproducts					
You practice the waste hierarchy (reduce, reuse and recycle)					
Bird droppings are decompose by composting for agricultural purposes					
You sell and have customers to buy up your dropping waste products as byproducts					
Bird dropping wastes are fermented for					

maggots rearing					
You ferment dropping for algae purposes					