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Review Article

A review of intensive contract poultry farming in Nigeria

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Abstract
Contract farming (CF) is a sort of vertical integration in agricultural commodity chains that provides a business with strong control over several operational processes, including the production process, the features of the items, quantity, quality, and timeliness of project execution. Birds were first domesticated by humans as farm animals, and as a result, many years ago, the contemporary practice of raising birds began with the harvesting of their eggs and young from their natural habitat. The Nigerian poultry industry falls into three main categories: small-, medium-, and large-scale, which are also referred to as backyard, semi-commercial, and commercial respectively. Contract farming emerged as an alternative to traditional or spot market-based agricultural production and was introduced into Nigeria under a variety of business names, including CHI, AMO, ANIMAL CARE, and ZARTECH, among others. Nigeria consumes 192.69 MT of poultry meat and egg products annually, resulting in enormous environmental impacts that have not been adequately addressed because of the growing use of contract farming. Contract farming has always received a lot of attention from academics and policymakers. Even though contract farming acknowledges the transfer of technology, prospects for increased revenue, and improved access to inputs, a great deal of research has focused on the risks that smallholder farmers face. In recent years, debate has erupted regarding the benefits and dangers of factory poultry production considering rising awareness of the challenges it poses to public health and the

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environment. This review reveals that backyard flocks of chickens can thrive independently of large-scale poultry operations. Survival traits including tiny size, hardiness, sluggish growth, low mature body weight, tolerance, or resistance to common local disease organisms and parasites define local chickens.

Keywords: *Contract farming, poultry, Nigeria, intensive.*

1.0 Introduction

1.1 An overview of contract farming

In agricultural commodity chains, contract farming (CF) is a type of integration, with a vertical magnitude that gives a company sound control over a series of operational processes such as production process, goods' characteristics, quantity, quality, and timing of project execution. Large estates or plantations have historically been used by businesses to achieve vertical integration, especially for traditional tropical commodities like sugarcane, bananas, and tea. All forms of contract farming give producers some degree of control over the process and product of production without the corporation being actively involved in the production. Consequently, recognizing that contract farming lies somewhere in between spot markets and investments that are fully vertically integrated; a company's involvement in the processes of the value chain is a good place to start (Kirsten and Sartorius, 2002; Young and Hobbs, 2002; Da Silva, 2005).

According to Catelo and Costales (2008), contract cultivating is a legitimately authoritative understanding as a "forward understanding" between an organization (the "project worker") and a solitary maker (the "contractee") that incorporates obvious commitments and pay for errands performed, as well as determinations with respect to item properties like volume, quality, and conveyance time. Da Silva (2005) opined that there is a central method of coordination where the provisions of the trade are explicitly set by lawfully enforceable, authoritative understanding between the exchange accomplices. The specifics can be essentially quick and dirty, covering game plans regarding creation advancement, cost disclosure, risk-sharing and other thing, and trade credits. Contract cultivating can be put inside two of the three regular sorts of rural agreements as per the definition given by Rehber (1998). Market-detail contracts are the first of these, and they guarantee a rancher a promoting outlet, a period of offer, and perhaps a cost structure on the off chance that quality is met. By tending to advertise data imbalances, market-determination contracts decrease coordination costs, especially for transient items or those with complex quality credits (Minot, 2007). Ranchers hold full creation control. The second sort of agreement is known as an asset-giving agreement, and it specifies that an organization should showcase the product in return for specific physical or specialized inputs. This lowers the cost to farmers of harvesting, transporting, and buying inputs, while the company is guaranteed the quality of the product and payback.

In industrialized countries, contract farming has long been common. The Japanese colonial state used CF to generate sugar in the late 1800s (Little and Watts, 1994). MacDonald and Korb (2011) stated that consumers' concerns are mostly focused on the food's safety and quality. Dolan and Humphrey (2000) state that CF originated in non-industrialized countries as a means of transporting high-value goods, such as green vegetables, to markets in wealthier countries. Over time, however, it has gradually become common practice for high-value crops to be transported to domestic general stores as well (Reardon and Timmer, 2012).

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Contract farming is given a lot of support by the World Bank (2007) because it can help modernize agriculture, reduce poverty, and introduce new high-value crops, better technologies, and marketing systems. Commodities related to agriculture can be traded on the spot market. However, customers may find it challenging to assess the safety and quality of some products, such as leafy vegetables. In addition, neither buyers nor sellers can be assured that they will be able to transact the desired amount at the desired time. Spot markets may have extremely high transaction costs as a result. Another option is the vertically integrated plantation system, which completely integrates marketing, production, and processing. Byerlee (2014) noted that plantation agriculture typically has very high management costs, especially when it comes to keeping track of how much hired labour costs. Contract farming lies in between these two.

According to FAO (2012), a contract that details the terms for the production and distribution of an agricultural product is called a CF. This contract is between buyers and farmers. There is agreement on a price or pricing formula that accounts for future market prices in addition to quantity, quality, delivery time, and inputs used (Kirsten & Sartorius, 2002; Wang *et al.,* 2014). There are generally two kinds of CF that are frequently talked about: Contracts for marketing (MC) and production (PC) (MacDonald *et al.,* 2011). In a PC, farmers normally supply the land, labour, and equipment, and the counterpart offers essential inputs like credit and technical assistance in return for the delivery of goods that meet predefined standards for quality and quantity. As such, the contractor has complete control over choices of farm management and output under the terms of this contract. Farmers, according to Key (2005), often choose PC's tight control on production autonomy. The contract's terms define the amount and calibre of the product that will be provided later, either at a predetermined price or using a pricing formula. Under MC, growers are largely responsible for their production. In other words, while PC offers inputs and technical services, MC is solely focused on the terms of product delivery.

The main objectives of CF, especially PC, are the failures of the labour, purchased input, finance, insurance, and product markets as well as the lack of a market for technology knowledge, according to Grosh (1994), Key and Runsten (1999), and others. Labour markets typically fail because of the high monitoring costs of hired labour, especially in care-intensive activities. (Hayami & Otsuka, 1993).

As a result, family farms produce most of the food on farms, as opposed to large farms that rely on hired labour. Due to the lack of specific high-quality input markets and affordable financing, the contractor under PC delivers high-quality inputs (such as better seeds and nontoxic pesticides) on credit in underdeveloped countries. It is possible to overcome product market failure brought on by asymmetric information about quality and safety by supplying the required inputs and closely observing production. Additionally, while though ranchers should assume the development risk, the contractor usually offers a fixed price for the product up front, which might reduce its worth. Contractors provide farmers with updated information about new technology and management, which is unique to PC and MC to some extent (MacDonald *et al*., 2004).

Abebe *et al.* (2013) pointed out that small-scale farmers in Ethiopia are highly motivated to receive vital agricultural inputs and technical assistance for potato production from agribusiness farms. Bellemare (2010) asserts that technical services significantly influence the efficiency of leafy vegetable production in Madagascar. The widely held view that CF helps modernize agriculture in underdeveloped countries is based on the availability of new technological knowledge and better

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material inputs.

1.2 History of contract poultry farming in Nigeria

The present practice of keeping birds began many years ago when people domesticated birds as farm animals, leading to the collecting of their eggs and young from their natural habitat. Nigerian poultry industry falls into three main categories: small-, medium-, and large-scale which are also referred to as backyard, semi-commercial, and commercial, respectively. Most of them are reared in southern Nigeria on intense or semi-intensive farms. According to Dada et al (2022), many of the nation's poultry houses in rural areas are subpar and managed by less experienced farmers who are unwilling to utilize new or relevant techniques for efficiently managing poultry production, which has a negative impact on yield. This was the main reason developing continents like Asia and Africa have historically consumed and produced less poultry than European countries (Augère-Granier, 2019). Other factors include inadequate capital and operating credit, climate change, and poor resource management (Ricke, 2017). However, the emergence of CF in the poultry subsector became a game-changer as reflected in the production and consumption statistics of chicken in Nigeria. Poultry contract farming started in Nigeria in the year 2012 by a poultry firm in Osun state called TUNS farm (source: personal communication) and has since then transformed the entire poultry value chain through introduction of better production practices. It actually emerged as an alternative to vertical integration system whereby a firm owns multiple stages of the production and marketing system. Over the years (between 2012 and 2024), more than 6 CF entities have emerged in Nigeria under a variety of business names, including CHI, AMO, SAYED, and ZARTECH, among others. The impact of CF on poultry production in Nigeria is quite significant as the number of chickens in the country has increased significantly from about 134 million in 2013 to 248 million in 2022 (FAO, 2023). According to the World Economic Forum (2019), it has been estimated that by 2030, there will be a 60% increase in demand for poultry products across the African continent, particularly in Nigeria, which is the largest poultry market. This suggests that CF, with its advantages and drawbacks for the environment, will become increasingly popular.

Contract farming agreements can be divided into five different "types" or models (Da Silva, 2005; Bijman, 2008). Firstly, there is the centralized model, where multiple farmers are hired by a big processor to achieve rigorous quality and quantity targets. Products like sugarcane, tea, coffee, cotton, milk, and poultry that work well with this contracting model require a lot of processing before they can be sold in stores, according to Eaton and Shepherd (2001). There are numerous levels of input supply. Furthermore, contracts for this approach are often negotiated with big farms because of the huge volumes needed for successful processing (Bijman, 2008). The second type is the nucleus-estate model, wherein an entity, usually a processor, contracts with independent producers (for more seeds or larger amounts) and joins the production node through a plantation or estate. Eaton and Shepherd (2001) reported that this model is often used in resettlement or transmigration programs, like Indonesia's palm oil production, and is usually preferred for perennial crops. Consequently, central estate growers are employed in this contract farming model. The third model is the tripartite model, in which farmers collaborate with a public-private joint venture. Contracts for this type are also often signed with large farms, because successful processing requires enormous volumes (Bijman, 2008). The other type is called the nucleus-estate model, wherein an organization, usually a processor, contracts with independent producers (for more seeds or larger amounts) and joins the production node through a plantation or estate. Fourthly, there is the informal model, in which a small number of farmers and small businesses

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enter into annual verbal agreements, typically for non-processed fruits and vegetables.

According to Eaton and Shepherd (2001), the extent to which the state and/or NGOs can provide inputs like credit and extension is a significant factor in the success of such initiatives, which typically target small businesses. This model frequently suffers from additional contractual side-marketing due to its informal nature. Finally, there is the intermediary model, in which a trader or farming committee subcontracts the company's interaction with farmers. Eaton and Shepherd (2001) claim that this model is a crucial factor in contract farming because it increases the distance between the farm and the corporation, which limits the degree of control a company has over the process and the result.

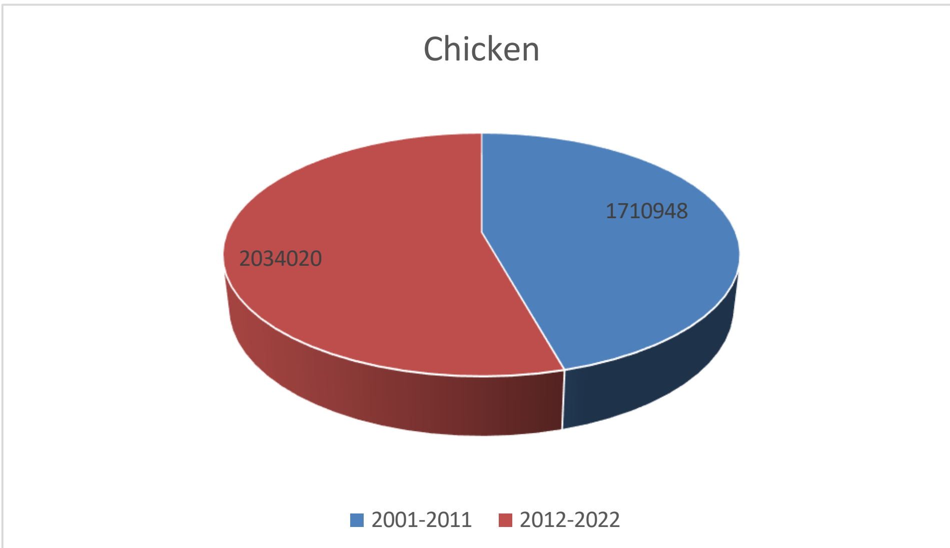

Figure 1: Comparison between different decades the chicken production in Nigeria (Source, FAO, 2023)

2.0 Livestock farming in Nigeria

Despite its heavy reliance on the oil industry, Nigeria's economy still relies heavily on agriculture. In 2008, agriculture contributed 24% of Nigeria's GDP, according to NBS (2010). Agriculture employs more than 70% of people in rural areas, making it the second-largest export industry after crude oil. According to Nwafor (2008), the industry plays a major role in wealth development and poverty alleviation. According to Rekwot *et al.* (2015), there are four subsectors within Nigeria's agricultural sector: crops, livestock, forestry, and fisheries. Rekwot *et al*. (2015) state that the agricultural GDP was primarily composed of crops (about 85%), animals (10%), fisheries (about 4%), and ranger services (about 1%). In recent years, the share of the crop and livestock subsectors has stayed the same, while the fishery has grown, and the forestry has decreased. The livestock industry is the primary source of animal protein in Nigeria. According to Uzonwanne *et al* (2023) and Sasu (2023), the livestock subsector's contribution to GDP has decreased over time, from 5.61 per cent in 1960 to approximately 1.27 per cent in 2023. Livestock production in Nigeria is a tool for improving socioeconomic transformation, revenue, and the standard of living in rural areas It is an important component of the agricultural economy in developing nations. According to Adeyemo and Onikoyi (2012), poultry is the most common type of livestock produced in Nigeria and can be found all over the country. The production of poultry has shifted significantly from a hobby to a profit-oriented business. According to Adeyemo and Onikoyi (2012), its unique offering of quick high turnover and returns on investment makes it to stand out.

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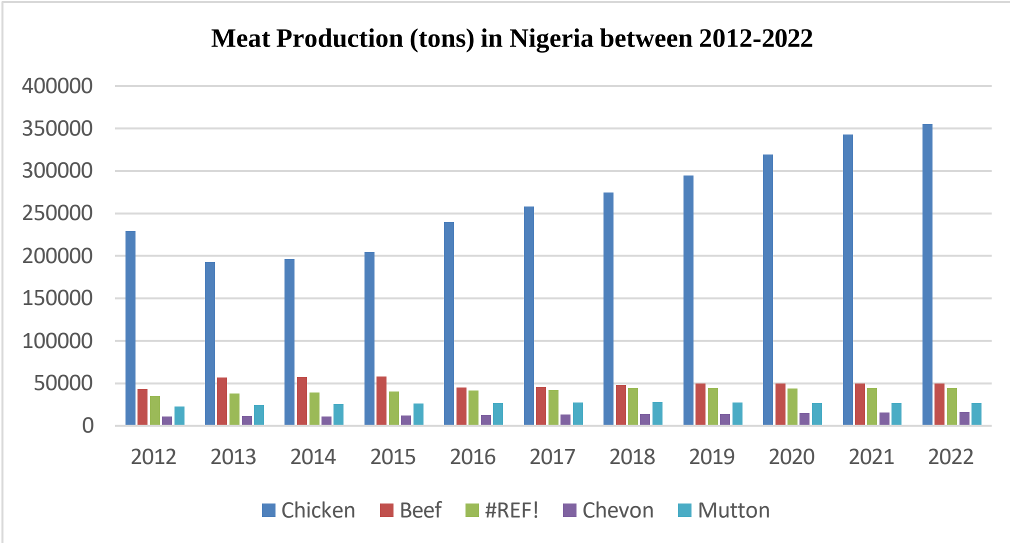

Source: FAO, 2023.

2.1 Poultry production as an important part of the livestock subsector in Nigeria's economy

One of Nigeria's most important components of the livestock subsector is the poultry sector. Nigeria's poultry business consists of both locally developed, unimproved breeds and well-performing commercial breed. While domestic chicken is driven by traditional system management, exotic breeds have fuelled the industrial advancement of the poultry industry through specialization as egg or meat type strains to meet the growing demand for poultry product in the food market over the past fifty years (Rekwot *et al*., 2015).

About 25 million people is the estimated commercial poultry employment, while about 85 million are in rural family poultry (Industry Review, 2023). These people include grain farmers, feed mill operators, and others whose products and services are used to help market and produce poultry. Poultry farming is viewed as a means of earning a living and achieving some degree of economic independence in Nigeria. According to Ogundipe and Sanni (2002), both dietary and financial reasons are the primary reasons poultry are kept in all parts of the country. According to Oladeebo and Ambe-Lamidi (2007), the biological demands, economic growth, and social development of any nation's population depend on the production of poultry as part of their livestock. Globally, chickens account for 91% of the world's total poultry population and contribute around 89% and 92% of poultry meat and egg production, respectively. The demand for foods of animal origin is expected to grow by 70% (2005–2050), and the highest expected shares would be contributed by poultry meat (121%) and 65% for eggs (Erdaw and Beyene, 2022). The poultry industry has the potential to supplement crude oil as a source of foreign earnings if properly utilized (The - poultry site news, 2009). Crude oil is currently Nigeria's primary source of foreign earnings. Poultry farming on a small scale presents a rare chance for investment, risk mitigation, and saving. Nwagu (2002) asserts that because poultry has so many applications, its production is particularly significant in the rural areas of Nigeria. Poultry meat and eggs, according to Folorunsho and Onibi (2005), have great promise for meeting human needs for dietary animal supplies.

2.2 Poultry production challenges

Despite its leading position in the livestock industry, the poultry sector is besieged with challenges. The difficulties associated with poultry production in Nigeria cannot be overstated. The industry's

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production rate has slowed down because of these difficulties. According to Ajala *et al*. (2007), a significant obstacle to poultry production is the high rate of disease and pest attack. The high rate of disease and pest attack in poultry presents several significant challenges such as economic losses due to mortality, reduced productivity, and increased costs for treatment and prevention. Sick birds may lay fewer eggs, grow slower, or produce inferior meat, leading to decreased revenue for poultry farmers. Disease and pest infestations also compromise the health and welfare of poultry and may lead to the increased use of chemical pesticides, which can have adverse environmental effects. Addressing these challenges requires a multifaceted approach, including improved biosecurity measures, vaccination programs, better management practices, and ongoing research into disease prevention and control. Sustainable farming practices, regular health monitoring, and education for farmers on best practices are also crucial in mitigating the impact of diseases and pests on poultry farming.

Lack of access to loans and credit procurement has also been the subject of numerous research (Agbato, 1997; Akeeb 1997; Adebayo and Adeola, 2005; Aromolaran, 2013). Poor access to loans and credit significantly affects the poultry business in several ways. It limits capital for investments in essential infrastructure and equipment. This includes modern housing, feeding systems, and automated equipment that can enhance productivity and efficiency. Also, farmers without sufficient funds cannot increase their flock size, diversify their product offerings, or enter new markets, which limits their growth potential and competitiveness. Other implications are cash flow problems, making it difficult to manage day-to-day expenses and maintain the health and productivity of the flock; higher production costs due to inability to buy feed in bulk at discounted rates and the inability to meet market demands. Overall, access to loans and credit is crucial for the growth, efficiency, and resilience of poultry businesses. Addressing these financial barriers involves improving financial literacy among farmers, developing tailored financial products for the agricultural sector, and fostering stronger relationships between financial institutions and poultry farmers.

Olaniyi and colleagues (2008) also noted a deficiency in technical knowledge. They cite another barrier facing the sector as the fact that most people enter the poultry farming business purely because they witness others make great money, but they do not obtain the knowledge required for producing chickens. Adeyemo and Onikoyi (2012) also identified a high mortality rate which they claim was caused by the availability of low-quality chicks. The majority of farmers buy their chicks from roadside vendors and are unaware of the farms that hatch them. Ajala *et al.* (2007), reported that mortality occurs primarily during the brooding stage. Another main issue is the high cost of poultry feed, as noted by Swan and Sonaiya (2004). The high cost of poultry feed presents several significant challenges in the poultry business. It directly increases the cost of producing poultry meat and eggs, reducing profit margins for farmers. It can also create cash flow problem for farmers as they need to continuously purchase feed to maintain their operations, and elevated prices can lead to cash shortages, making it difficult to cover other essential expenses like labor, maintenance, and healthcare for the birds. This could result in compromised feed value and reduced meat and egg quality as some farmers might resort to purchasing cheaper, lower-quality feed. Exploring alternative feed sources, such as insect meal or agricultural by-products and implementing precision farming techniques to optimize feed use including subsidy are notable measures to address the problem.

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Inadequate poultry extension services are one of the biggest problems the poultry sector is now facing, according to Adeyemo and Onikoyi (2012). Another major challenge facing the industry is the lack of access to and high cost of veterinary administrations, as noted by Adeyemo and Onikoyi (2012) and Anosike *et al*. (2015). The high cost of veterinary administrations poses significant challenges to the poultry business in several ways viz: increased operational costs, financial strain on small farmers, reduced preventive care, increased mortality and morbidity, disease outbreaks, compromised animal welfare, reduced productivity and quality. Poultry farmers and industry stakeholders can consider cooperative healthcare models and insurance programs as measures for addressing the problem.

2.3 The need to review contract farming

Contract farming has always received some attention from academics and policymakers outside Africa. Even though contract farming acknowledges the transfer of technology, prospects for increased revenue, and improved access to inputs, a great deal of research has focused on the risks that smallholder farmers face. (Little and Watts, 1994; Porter and Phillips-Howard, 1997). For instance, how these arrangements can result in a loss of autonomy and more debt, how contracts were frequently manipulated with late or partial payments, and how the distribution of labour and income within a household was frequently altered in a manner that was detrimental to the interests of women. Many of these conclusions were based on case studies authored by sociologists, anthropologists, and political economists who were interested in how effects were dispersed among social groupings in addition to the mean effect across participants (Grosh, 1994).

Contract farming receives a much better rating from numerous recent econometric studies that correct for selection bias and use micro-level survey data. The main topics of this study field are smallholders' involvement in vertically integrated value chains and the consequences of that involvement, especially about smallholder farmers' earnings.

Runsten and Key (1999), and Kirsten and Sartorius (2002) offered a more pessimistic interpretation, for instance; though many of these authors are aware that smallholder farmers occasionally engage in contract farming. Reardon *et al.* (2009), in contrast, presents a more optimistic interpretation, arguing that there are several exceptions to the general rule that smallholders will almost always be excluded from dualistic agrarian economies. Furthermore, Reardon *et al*. (2009) stated that although wealthier smallholders usually dominate, small-sized farms often participate in vertically integrated networks and perform better. Additionally, Swinnen and Maertens (2007) argue that even though theory suggests that smallholders should be excluded from participation due to investment constraints and transaction costs, empirical research suggests a much higher level of participation. In the past ten years, the impact of participation has changed significantly more clearly in the literature. Minten *et al*. (2009), as well as Setboonsarng *et al.* (2008), demonstrate that contract growers earn significantly more than their counterparts who were not under any outgrower farming arrangement. According to Reardon *et al*. (2009), farmers who engage in contemporary food business channels make more money per hectare or kilogram sold than those who solely engage in conventional channels.

3.0 Contract farming transactional costs

Noncompliance with contractual terms and holdup are potential transaction costs of contract farming. When market prices exceed the authorized price, farmers may sell their products to the market or rival contractors when higher product prices are available. They may also divert their

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provided inputs for other uses (Dries *et al*., 2009; Barrett *et al*., 2012). Poulton *et al* (2004) asserted that increased buyer competition increases side selling opportunities. The primary threat used in contract enforcement is the contract's non-renewal (Bellemare, 2010). Encouraging farmers to comply with contractual commitments by offering a price higher than what the market offers is necessary. In the event of PC, the contractor may also use agents to keep an eye on the activities of farmers to enforce contracts (Marcoul and Veyssiere, 2010). Farmers usually require contract-specific assets like greenhouses, cooling storage, and poultry houses. Post-contractual opportunism, also known as the opportunity, to modify the terms of a contract, nevertheless exists because it is impossible to anticipate all possible outcomes (Wu *et al.*, 2014).

Farmers lose money when a contractor modifies the terms of the agreement for their gain since contract-specific assets cannot be sold for fair prices, which results in less capital being spent on contract-specific projects. The expectation of future rewards and punishments via repeated business can be a powerful motivation for people not to use their ex-post discretion opportunistically, much as in the case of breaching a contract. Gow and Swinnen (1998) suggest that foreign companies operating in transition economies should invest in contract-specific processing facilities and support services, offer long-term contracts, and uphold a reputation for fairness and honesty to address holdup difficulties. In contrast, according to Schipmann and Qaim (2011), a lack of trust is the reason why many farmers in Thailand leave CF. According to Singh (2002), there is a lack of trust between contractors and farmers in the Indian Punjab, which suggests that CF may not be sustainable there.

According to data, 74% of the world's poultry meat and 68% of its eggs are produced using intensive methods (Reardon and Timmer, 2012; Rekwot *et al*., 2015). Some intensive farming methods have emerged because of an economic imperative. For instance, between the ages of 16 and 20 weeks, hens begin to lay eggs, but egg production begins to decline around the age of 25 weeks. Since these hens are deemed economically unviable at 72 weeks of age, several countries slaughter them at the one-year milestone of egg production. An essential component of intensive poultry farming is the utilization of standard battery cages for laying hens. Battery cages hold more than 5 billion laying hens globally, with each hen using less area than an A4 sheet. (Reardon and Timmer, 2012; Rekwot *et al*., 2015).

3.1 Gaseous pollutants

As the chickens develop and move into their cages, their droppings end up on the floor. The droppings decompose, allowing ammonia to escape. The harmful vapours that the ammonia releases into the air might cause chickens to suffer from severe blisters, hock burns, or ulcerated feet. The media has focused a great deal of emphasis on Nigeria's industrial livestock and poultry industry. Controlling this pollution must be a top priority, likely because it occurs in rural areas and its effects are frequently regarded as local. The vast majority of Concentrated Animal Feed Operations (CAFOs), particularly the small and modestly estimated ones located moderately far from metropolitan areas, lack dedicated contamination control measures. Air emissions and the disposal of a lot of animal waste can cause livestock and poultry CAFOs to release a variety of pollutants into the environment. As well as adversely affecting the nature of the air, surface water, soil, and groundwater, these poisons likewise represent a danger to general well-being (Reeve *et al*., 2013). Livestock raised in confined animal feeding operations emit a range of gaseous pollutants and bioaerosols during the handling, storage, and application of manure on land. Most of the compounds released by animals and from the breakdown of their manure include carbon

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dioxide, methane, ammonia, hydrogen sulphide, volatile acids, mercaptans, and amines with low odour thresholds (Cole *et al*., 2000; Donham *et al*., 2006; Centner and Patel, 2010; Pohl *et al*., 2017).

The main sources of particulate matter and bioaerosols (bacteria, endotoxins, fungi, mycotoxins, -glucans, and particles of plant and animal origin) are dust and dried faeces particles, as well as actions like handling and spreading waste that has the potential to aerosolize the material (Schinasi *et al.*, 2011). As a result of ammonia and other N-containing chemicals volatilizing due to organic matter decomposition, the nitrogen content of animal waste in the storage lagoons reduces (Harper *et al*., 2004). Another gaseous by-product of concern that is produced during the anaerobic decomposition of animal manure is hydrogen sulphide (Greger and Koneswaran, 2010; Pavilonis *et al*., 2013). Microbial agents and products, together with gaseous products, may be emitted into the atmosphere when animal manure is sprayed into fields, particularly if it is done excessively (Greger and Koneswaran, 2010). More than one-third of the methane emissions in the world are caused by the decomposition of animal manure and the intestinal fermentation of ruminants, mostly beef and dairy cattle (Steinfeld *et al*., 2006). The management of manure and enteric fermentation accounted for 25.4% and 10.1%, respectively, of all anthropogenic methane emissions in the US in 2015 (USEPA, 2017).

According to a recent modelling study, the number of animals raised for meat, eggs, and dairy products has increased rapidly in Nigeria. Within 1 km of poultry CAFOs, hydrogen sulphide and ammonia concentrations could exceed background levels by more than an order of magnitude, and they could affect air quality within a range of several kilometres (Pohl et al., 2017). The gaseous pollutants and bioaerosols from CAFOs can also contaminate soil and water, which can affect local and even regional air quality. For example, surface water eutrophication can happen when a considerable quantity of ammonia emitted into the atmosphere by animal manure put on land and storage lagoons ends up in nearby surface water bodies through dry and wet deposition (Costanza *et al.*, 2008).

3.2 Pathogens

Greger and Koneswaran (2010) state that a range of enteric pathogens, such as bacterial, viral, and parasitic infections that are also infectious to humans, can infect livestock and poultry, including pigs, cattle, and chickens.

As a result, numerous microbes can be found in the waste from domesticated poultry and animals. Production facilities in CAFOs, particularly those that house pigs, routinely flush away animal waste, and the resulting slurry is gathered and kept in storage lagoons (Heaney *et al*., 2015). The anaerobic digestion of animal waste in the storage lagoons may eliminate or significantly reduce many pathogenic microbes, but these microbes may still be present in large quantities in lagoon waste spills and seepage, which could contaminate surface and groundwater (Burkholder *et al*., 1997; Gentry-Shields *et al*., 2015). At temperatures above 55°C, composting can also dramatically lower the number of pathogens in manure; however, inconsistent pathogen reduction may still occur if adequate management is not followed (Tiquia *et al*., 1998; Turner, 2002).

Apart from the conveyance of animal waste pathogens to soils, surface waters, and groundwater by land application, seepage, spills, and overflows from manure storage lagoons can also cause pathogenic contamination of surface waters and groundwater. After being applied to land, the

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pathogens in manure can linger for a long time in storage lagoons and soils (McLaughlin *et al*., 2012). The ability of pathogens to survive depends on how they interact with natural microbial communities and environmental elements such as soil moisture and nutrient content when treated or untreated animal faeces are applied to the ground (Avery et al., 2012). According to Guan and Holley (2003), enteric pathogens typically flourish in soils rather than manure or slurries, and low temperatures help them survive. Bacteria, viruses, and protozoa can live in soils for two months, three months, and two days, on average, according to Gerba and Smith (2005). Depending on the soil's characteristics and supplemented organic wastes, bacterial pathogens in soils have been shown to live for a few days to over a year (Avery *et al*., 2012). Pathogens carried by manure into rivers and lakes can also be introduced by runoff from farmlands fertilized with manure and rains and irrigation water, as well as by leaching into groundwater from the farmlands and storage lagoons. It had long been known that rivers near animal farms had seen a significant increase in pathogen concentrations. Enteric bacteria were observed to commonly move from soil treated with manure to surface and groundwater by Gagliardi and Karns (2000). In China, animal husbandry has led to a pervasive contamination of surface waters with human waste (Chen *et al*., 2011; Zhuang *et al*., 2017). When there are high levels of pathogens carried by manure, water resources' safety and quality suffer (Zhuang *et al*., 2017).

3.3 Antimicrobials, oestrogens, and heavy metals

Animal waste mostly consists of organic matter, nutrients, dissolved solids, and salts, but it also contains a range of feed additives and veterinary medications that are fed, injected, or ingested by farmed animals. Trace elements are regularly added to animal feed to improve the health and performance of the animals. Veterinary medications, especially antibiotics, are mostly used in food animal production to promote growth and control sickness. These medications and feed additives are used to produce food animals, which causes animal faeces to release significant amounts of them into the environment. (Li *et al.*, 2014).

Additionally, the faeces and urine contain steroid hormones that are administered to animals and those that are produced naturally by animals. Pollutant-laden wastewater and liquefied animal dung may enter nearby rivers and other water bodies due to accidental spills, manure runoff, and sometimes deliberate releases. Animal manure, whether treated or not, can enhance the fertility and qualities of soils; however, the resultant build-up of pollutants, especially non-degradable heavy metals, can lead to serious environmental issues and potentially endanger the ecosystem (Hu *et al*., 2010). Rainwater and irrigation water can also leach antimicrobials, steroids, and heavy metals from animal waste applied to agricultural fields. Aquatic life can be affected by this, which can contaminate groundwater as well as surface water. Animal waste disposal has historically been associated with problems related to organic matter, nitrogen, phosphorus, and microorganisms; however, in general, antimicrobials, steroid hormones, and heavy metals present in the waste have become major environmental concerns. (Hu *et al.,* 2010).

3.4 Risks to human health from pollutants

Human health may be impacted by a variety of pollutants from animal faeces that are discharged into the air, surface water, soil, and groundwater, as well as by gaseous pollutants and bioaerosols from CAFOs. Antimicrobial resistance (AMR) is a global issue that has the potential to seriously endanger public health due to its selection and spread. Furthermore, it is common knowledge that the public finds the offensive and disagreeable smells emanating from animal faeces in CAFOs to be a nuisance. It is critical to remember that vulnerable groups are more likely to be exposed to all

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pollutants from CAFOs, including small children, the elderly, pregnant women, and people with compromised immune systems (Burkholder *et al*., 2007; Greger and Koneswaran, 2010). Certain organic contaminants and heavy metals that have accumulated in soils due to animal manure amendments can be absorbed by crops and vegetables, providing a health concern to humans, because they reach the food chain. Antimicrobials such sulfonamides, tetracyclines, and quinolones have been discovered to be present in vegetables grown on soils fertilized with animal dung at concentrations as high as several hundred g/kg (Hu *et al*., 2010; Wu *et al*., 2014; Zhang and Cheng, 2017).

Plants contain antimicrobials at levels far below those considered safe for consumption by humans or animals (Dolliver *et al.*, 2007). Heavy metals such as cadmium and lead are found in grain form in cereal plants such as maize, wheat, and rice (Athar and Ahmad, 2002; Cheng *et al*., 2007; Hu *et al*., 2016). Hu *et al*. (2016) attribute the extensive heavy metal pollution of Chinese soils and the creation of Chinese firms in Nigeria, including CHI Ajanla Farms and Zartech Farms, to the combined effects of intensive industrial expansion and weak environmental protection. On the other hand, regular application of animal dung to farmlands in rural regions with minimal industrial activity can add heavy metals to the surface soil. Thus, the subsequent absorption and accumulation of these metals in vegetables and cereal grains might directly adversely affect the health of consumers. Foods derived from animals, such as meat, milk, and eggs, may also include trace levels of drug residues due to the widespread use of antimicrobials and other veterinary medications in the raising of food animals. This leads to worries regarding food safety (McKinney *et al*., 2010).

Antimicrobials have a limited direct harmful effect on humans and are generally detected in very small concentrations in food crops and animal products damaged by CAFO manure. On the other hand, the emergence and dissemination of antimicrobial resistance (AMR) in CAFOs due to antibiotic abuse highlights a possible risk to public health. The natural and inevitable selection of antibiotic-resistant bacteria occurs from the widespread use of subtherapeutic doses of antibiotics for prolonged periods of time in CAFOs (Mathers *et al.*, 2011). Barrett (2005) claims that airborne germs can quickly transfer AMR from farmed animals to CAFO employees and nearby communities. Due to their frequent exposure to air pollution from CAFOs and their near proximity to hundreds to thousands of farmed animals and their wastes, workers at CAFOs are particularly vulnerable to risk (Barza, 2002). Even though methicillin-resistant Staphylococcus aureus (MRSA) has been widely detected among swine industry workers (Khanna et al., 2008; Smith et al., 2009), resistant bacteria have been found at levels that could be harmful to human health in animal confinement facilities and near CAFOs (Gibbs *et al*., 2004). Through direct contact with and consumption of food derived from animals, particularly meat products, AMR that has developed in animal farms can also spread to humans. Jiang and Shi (2013) noted that ongoing research has shown that food-borne microorganisms carry a moderately high amount of AMR in animal products and a pattern that is generally expanding in organisms that produce food (Lai *et al.*, 2014). The incidence of AMR reduces the effectiveness of human medications because most antimicrobials used in animal husbandry, including quinolones, tetracyclines, macrolides, sulfonamides, and tetracyclines, are also commonly used in human medicine or are closely related to drugs that are important for human health (Marshall and Levy, 2011). The link between antibiotic use on food-producing animals and AMR in people is complicated, difficult to measure, and even divisive (Jensen *et al*., 2004; Smith *et al*., 2005; Van Bunnik and Woodhouse, 2017). It is well known that the extensive use of antibiotics in medical treatment greatly increases the risk

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of antimicrobial resistance (AMR) in humans; nonetheless, determining the precise amount that the indirect pathways of AMR transmission from animal farms to the public contribute to AMR can be difficult (Holmes *et al*., 2016).

4.0 Adoption of locally improved strains of poultry: Way forward

Systematic research is needed to understand the fate, transport, and interactions of veterinary drugs and feed additives used in animal farming, as well as their metabolites, in soil, surface water, and groundwater. This will help us better understand the environmental impacts and public health risks associated with these substances. The indiscriminate use of antibiotics to correct subpar production techniques and promote animal growth is one of the primary causes of the onset of AMR in CAFOs (Clark *et al*., 2012). Marshall and Levy (2011) state that one practical way to lessen the negative environmental impact is to gradually stop using antibiotics as animal growth boosters. By providing adequate nutrition, reducing animal overcrowding, and improving sanitary conditions, infectious diseases can be significantly reduced in CAFOs (Hu and Cheng, 2016).

Additionally, the utilization of locally improved strains of poultry birds will result in increased resilience and adaptability, thereby lowering the requirement for an excess of veterinary medications (Jordan, 2013). In recent years, debate has erupted regarding the benefits and dangers of industrial livestock and poultry production considering increasing awareness of the challenges it poses to public health and the environment. By and large, family cultivates and "unfenced" ranches are related with less food handling and natural worries contrasted with CAFOs, albeit this could to some degree result from the absence of understanding on the exercises and practices of these homesteads and their moderately little and restricted influences. They cannot, however, keep up with the rising demand for meat and dairy products and are typically inefficient. However, using more environmentally adapted strains—like FUNAAB ALFA—is a good idea. Additionally, the cumulative environmental effects of many small farms may still be significant, even if they would be more difficult to measure than a small number of CAFOs (Holmes *et al.*, 2016).

However, despite the oil boom and the emergence of commercial poultry businesses in urban and suburban regions, the numerous accounts suggest that rural chicken production is predominantly small-scale and has been around for a long time. Both the number of local chickens and keepers have remained constant. Therefore, backyard flocks of hens can prosper without the assistance of large-scale poultry farms. Ibe (1990) claims that the survival traits of the indigenous hens include hardiness, small size, delayed growth, low mature body weight, tolerance, or resistance to common disease organisms and parasites. Although the hens exhibit good fertility and hatchability, they are early sexually mature and somewhat nervous. According to Oluyemi and Roberts (1979), they only produce a small number of white-shelled eggs of small size. They also have a reputation for always being gloomy.

Since bird-to-bird examination of the neighbourhood chickens is presently sensible and there is hereditary arrangement been made (e.g. FUNAAB ALFA). In Nigeria, improved local chicken strains provide a wide range of options for adaptability, environmental safety, and human health (Holmes *et al.*, 2016).

5.0 Conclusion

Intensive contract poultry farming has gained traction as a prominent method of poultry production in many parts of the world including in Nigeria due to its various economic benefits to farmers and

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companies. These include risk mitigation, technical support, and stable income for farmers including efficiency of production. However, it also presents significant challenges, particularly concerning environmental impact, farmer autonomy and the concerns about animal welfare. Addressing these challenges through sustainable practices, ethical standards, and supportive policies is essential for the long-term viability and acceptability of this farming model. This paper recommends effective waste management systems to mitigate environmental impact, maintaining strict biosecurity measures to prevent disease outbreaks, and adherence to ethical practices concerning animal welfare among farmers and companies in order to minimize the problems of the intensive contract poultry farming in Nigeria while also maximizing its gains. This will no doubt help the scaling of the initiative to a wider segment of the livestock sub-sector in Nigeria.

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