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Effect of the Poultry Industry on the Global Warming and Climate Change-A Review

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Abstract

The objectives of this paper are to review the effect of the Poultry industry on global warming and climate change. Livestock production in general and poultry production, in particular, contributes to global warming through emissions of methane and nitrous oxide. Poultry production is affected by the impact of climate change and also contributes to it. On the other way, the demand for animal-source food is increasing because of population growth; rising income and urbanization, and food preferences. Poultry protein production for human consumption is relatively cheap and egg and meat are sources of high-quality protein, vitamins, and minerals in human consumption. Poultry contributes to climate change by emitting greenhouse gases (GHG) either directly from manure management or indirectly from feed-production activities, conversion of forests into croplands. Most of the publications reviewed indicated that, from all indications, the majority of GHG emissions generated from the poultry industry occurs during the production stage and specifically come from propane and electricity use. Based on different research reports, the magnitudes of environmental impacts are highly dependent on production practices and especially manure management. Many literature reviews reported that, some mitigation strategies are included, farm management, manure management, nutrition management, and feed production. Therefore, poultry farmers must constantly pursue advancements in housing technology to improve their farms in order to be competitive and successful while minimizing the detrimental effects of global climate change.

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Global warming,
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Introduction

Global warming refers to a slow rise in the average temperature of the earth's atmosphere and oceans, which is thought to be irreversibly altering the planet's climate. Livestock production systems are thought to have a number of detrimental environmental effects, including nutrient leaching and a large contribution to global warming (Steinfeld *et al.*, 2006). By the middle of the twenty-first century, demand for animal products is predicted to have increased by 100% (Garnett, 2009).These industries account for 14.5 percent of global GHG emissions (Gerber *et al.*, 2013), which could result in increased land degradation, air and water pollution, and biodiversity loss (Bellarby *et al.*, 2013; Reynolds *et al.*, 2010). Green house gas emissions from livestock farming include CO2, nitrous oxide, and methane. One of the fastest-growing agricultural sub-sectors is poultry.

Over the last five decades, the average yearly growth rate for beef, pig, and small ruminant meat has been only 1.5 percent, 3.1 percent, and 1.7 percent, respectively (Alexandratos and Bruisma, 2012). The globe now contains over 23 billion chickens, or around three per person (FAOSTAT, 2016), which is more than five times what it was 50 years ago.

Green house gas emissions from the cultivation of crops needed to feed poultry, as well as fossil fuel usage during poultry rearing should be incorporated in a life-cycle study. Global climate change has been related to increases in GHG levels in the atmosphere (Verge *et al.*, 2009). Poultry contributes to climate change by directly or indirectly producing greenhouse gases. Poultry produces 0.57 pounds of methane per animal per year, dairy cattle create 185 to 271 pounds, and pigs produce 10.5 pounds per animal per year (Monteny *et al.*, 2001). Direct emission of harmful elements into the atmosphere or indirect deposition of these compounds into ground water has a negative influence on ecological systems. The environment in poultry housing is a complex dynamic system of social interactions, husbandry system, light, temperature, and the aerial environment that interacts as a complex dynamic system of physical and biological elements (Sainsbury, 1992). As a result, environmental regulation is becoming more prevalent over the world, and poultry producers must comply. The off-site consequences of poultry production have expanded dramatically as the scale, concentration, and intensity of operations has increased. Poultry production harms the environment in a variety of ways, including poor manure and litter management, processing plant waste streams (blood, bones, and feathers), bird carcasses, dust, insects, and odor. As a result, the purpose of this review was to examine the impact of the poultry industry on global warming and climate change.

Poultry industry Impacts on environment

Concerns about the environment at the local level stem from two factors. The abattoir and the animal production site.

Animal production site

Local disturbances and poultry carcass disposal

Poultry operations emit odors and attract flies, rodents, and other pests, which cause nuisances in the neighborhood and spread disease. The odors emitted by poultry farms have a negative impact on the lives of those who live nearby. Fresh and decomposing waste materials such as manure, carcasses, feathers, and bedding/litter give off an odor (Ferket *et al.*, 2002). In places prone to floods or with a shallow water table, improper disposal of poultry carcasses can lead to water-quality issues. The disposal of large numbers of diseased birds has brought new and difficult problems connected with environmental contamination in recent highly pathogenic avian influenza (HPAI) outbreaks.

Poultry manure

Manure management accounts for around 40–60% of the global warming potential of poultry systems, as well as their eutrophication and acidification potential (Leinonen and Kyriazakis, 2016). Poultry manure contains a lot of nutrients like nitrogen and phosphate, as well as other expelled chemicals including hormones, antibiotics, pathogens, and heavy metals that are introduced through feed (Steinfeld *et al.*, 2006; FAO, 2006).

Nutrients and heavy metals

Feed production and transportation represent around 70% of the global warming potential of poultry systems among the many sub-processes (Leinonen and Kyriazakis, 2016). Animals raised in intensive production systems require a significant amount of protein and other nitrogen-containing compounds. Dietary nitrogen conversion to animal products is inefficient; 50 to 80 percent of the nitrogen is excreted (Arogo *et al.*, 2001). Both organic and inorganic substances excrete nitrogen. Ammonia (NH3), dinitrogen (N2), nitrous oxide (N2O), and nitrate are the four main nitrogen outputs from manure (NO3-). Trace elements enter poultry diets through contaminated feedstuffs or feed additives. Arsenic, copper, and zinc are just a few of the potentially dangerous metals found in manure (Bolan *et al.*, 2004). These elements, in excess, can be poisonous to plants, have negative effects on creatures that feed on these plants, and enter water systems via surface run-off and leaching (Gubta and Charles, 1999).

Drug residues and Pathogens

Antimicrobial drugs are given to poultry for therapeutic or disease prevention purposes. Antimicrobial drugs are utilized as feed additives at considerably lower levels to speed up growth and enhance feed efficiency (Steinfeld *et al.*, 2006; FAO, 2006). Antimicrobial drugs provided to confined poultry are predicted to be excreted back into the environment in 75 percent of cases, regardless of dosage (Addison, 1984). Research evidence suggests that the interaction between bacterial organisms and antimicrobials in the environment may contribute to the development of antimicrobial-resistant bacterial strains (Chee-Stanford *et al.,* 2001). *Cryptosporidium* and *Giardia* spp. transfer from manure to water and can survive for lengthy periods of time in the environment (Bowman *et al.,* 2000). Generally pathogens in manure might possibly harm soil and water resources, especially if it is not properly managed.

Slaughter House

The dumping of wastewater into the environment is an environmental issue caused by slaughterhouse operations. In poultry slaughterhouses, water is used for evisceration, cleaning, and washing procedures (EU, 2002).

In contaminated feathers, feet, and intestinal contents, up to 100 distinct types of microorganisms, including diseases, may be found in poultry by-products and waste (Arvanitoyannis *et al.,* 2007). Poultry slaughterhouses discharge vast volumes of waste into the environment, contaminating land and surface waters and providing a major health danger to humans.

Global Warming and Climate Change

The greenhouse effect is created by the interaction of the earth's atmosphere with incoming solar radiation, which causes global warming. Overall, three distinct sources of environmental impacts from poultry production may be identified: (1) feed production, (2) direct farm energy usage, and (3) emissions from housing and manure management (Steinfold *et al.,* 2006). Poultry production has a significant environmental impact. Poultry production, impact on the environment is mainly from1) Excretion of excess nitrogen and phosphorus, (Conley *et al.,* 2009).

Direct greenhouse gas (GHG), which contributes to climate change

Ammonia emissions responsible for acidification and eutrophication of N-limited ecosystems (Sutton *et al.,* 2011).

CO2, CH4, and NO2are the three primary GHGs. Environmental effects of poultry production include both local and global effects. The manufacturing of concentrate feed and the creation of GHGs connected to energy use in animal production processes and in the transportation of processed goods are both relevant challenges.

Intensification of feed production

The intensification of feed production, the growth of agriculture, can cause the loss of biodiversity. The livestock sector's demand for feed has sparked three significant global developments. The excessive use of mineral fertilizer, insecticides, and herbicides to sustain high crop yields pollutes land and water resources, affecting land and water resources. Through the volatilization of ammonia, nitrogen fertilizer application to crops is a primary source of air pollution. Through changes in land use, feed production to meet the feed demand of intensive systems has an indirect impact on the global land base. Most cases of area expansion result in forest destruction. Land use changes can have a big impact on carbon fluxes, resulting in more carbon being released and fueling climate change. Deforestation has an impact on water cycles, increasing runoff and, as a result, soil erosion, in addition to changing carbon fluxes. Through land usage and land-use change, as well as the altering of natural ecosystems and habitats, intensive feed production contributes to biodiversity loss. Greater production and exports from nations such as Brazil have resulted from increased demand for feed. Soybean production in Latin America more than doubled to 39 million hectares between 1994 and 2004 (FAOSTAT, 2006).

Greenhouse gases emissions

According to Dunkley (2011), propane used for brooding young birds during colder months of the year accounted for around 65 percent of GHG emissions from broiler and pullet farms, but only 0.3 percent of emissions from breeder farms. Dunkley (2011) found that electricity was responsible for roughly 85 percent of GHG emissions on breeding farms, while electricity was responsible for 30 and 29 percent of emissions on pullet and broiler farms, respectively.

Carbon dioxide

Because of the sheer volume of its emissions, carbon dioxide has the greatest direct warming effect on global temperature. Animal respiration, natural gas combustion for heating and cooking, and decomposition of organic matter are all sources of CO2 in livestock (Knizatova *et al.,* 2010). Birds' CO2 output is related to their metabolic heat production and, as a result, to their metabolic body weight. For process applications and cleaning, as well as the functioning of mechanical and electrical equipment, processing facilities need energy to heat water and produce steam. The use of fossil fuels for transportation poultry meat contributes significantly to CO_2 emissions from international trade in poultry meat. By combining traded volumes with respective distances, vessel capacities and speeds, fuel use of main and auxiliary power generators for refrigeration, and emission factors, carbon dioxide emissions can be determined. The usage of fossil fuels accounts for a large portion of the CO_2 equivalent produced by the poultry sector. Purchased energy to power equipment in poultry houses (lights, fans, feeders, etc.), brooders (to keep young chicks warm), incinerators, and diesel fuel used in vehicles, tractors, and standby generators are all aspects of this (Dunkley, 2011).

Methane

Methane is a greenhouse gas with a significant global warming potential, having a GHG affect 23 times that of CO2. CH4 is produced through the fermentation of organic materials in animal housing, manure storage, and manure application (Broucek, 2014). When anaerobic circumstances cause organic carbon molecules to decompose. Anaerobic conditions can develop in the soil, in stored manure, in an animal's gut during enteric fermentation or during incomplete combustion of burning organic materials. Age, bodyweight, feed quality, digestive efficiency, and activity are all aspects that affect the animal's performance (Seinfeld *et al.*, 2006). When manure is kept or processed in anaerobic environments, such as lagoons, the biodegradable component of the waste decomposes, releasing CH_4. When manure is handled as a solid, such as in stacks or pasture deposits, the biodegradable part decomposes aerobically, lowering CH_4 emissions significantly (Saggar *et al.*, 2004). This method, however, may raise N_2O emissions, which have a higher global warming potential than CH_4.

Nitrous oxide

Nitrous oxide (N_2O) is a highly potent greenhouse gas (GHG) with 310 times the global warming potential of CO_2 (Oenema *et al.*, 2005). N_2O has a long life in the atmosphere and contributes greatly to global warming. It is transformed to NO, which decomposes the stratospheric ozone layer, which protects the Earth from dangerous UV radiation (Schulze *et al.*, 2009). The nitrification–denitrification process can convert excess nitrogen in agricultural systems to nitrous oxide. The content of the feces, the bacteria and enzymes involved, and the conditions after excretion all influence the formation of N_2O from poultry manure.

Factors influencing emission intensity

Feed conversion ratio (FCR) and land-use change

Broiler meat has 45 percent higher emission intensity than layer eggs. The reason for this is that the FCR of broilers is 22% higher than that of layers. As a result, producing one kilogram of meat requires 22% more feed than producing one kilogram of eggs. Due to their reduced physical performance, backyard systems have much greater FCRs than layers or broilers. As a result, the quantity of nitrogen excreted per kilogram of protein produced is higher in backyard systems, resulting in increased manure N_2O emissions (FAO, 2013). A major source of emissions is increased demand for feed crops. Chicken with a higher proportion of their ration made up of soybeans grown in areas experiencing land-use change (LUC) had significantly higher feed emissions.

Manure management

The pace at which volatile solids (VS) or nitrogen (N) are expelled, as well as the rate at which they are transformed to CH_4 or N_2O during manure management determines manure emissions. High FCRs and low feed digestibility result in higher VS and N excretion rates. Nearly 98 percent of GHGs in the atmosphere include carbon dioxide, CH_4, and N_2O, all of which are essential consequences of human activity, particularly animal agriculture (NAMI, 2009). In poultry, uric acid is rapidly converted to ammonia nitrogen, which is easily distributed into the surrounding air due to its volatility (Dunkley, 2011).

Flock structure and energy use

The breeding overhead in commercial chicken systems is tiny; hence it has a minor impact on the overall emissions intensity in these systems. In backyard systems, however, the breeding overhead can have a big impact on emissions intensity (FAO, 2013).Growing, processing, and transporting broiler, layer, and turkey feed accounted for the majority of all GHG emissions associated with poultry production (Steinfeld *et al.*, 2006). Emissions from energy consumption account for 37% of total emissions from egg production and 41% of emissions from chicken meat production. The use of fossil energy in feed production, such as for fertilizer manufacture, field activities, and delivery, also had a significant impact on the global warming power and primary energy use environmental impact categories. The second source of impacts was direct farm energy usage, which includes electricity, gas, and oil used in broiler, egg, and breeder farms and hatcheries (Steinfeld *et al.,* 2006).

Technical mitigation options

Farm and nutrition management

Management solutions such as improving poultry housing have the potential to improve the poultry industry's environmental sustainability (Leinonen and Kyriazakis, 2016). Environmental considerations can be factored into all farm management practices, reducing the effects felt at the production level. Odour emissions can be reduced by reducing the amount of manure that comes into contact with the air, cooling animal dung, lowering the water content of litter, and erecting wind protection structures.

By lowering excessive nitrogen excretion, dietary modulation can be an efficient way to reduce ammonia emissions. By restricting excess food intake and/or boosting the animal's nutrient usage efficacy, nutritional management tries to reduce pollutant load. Feed conversion ratios can be improved through proper diet balancing and feeding regimens, as well as feed digestibility. As a result, there are essentially two strategies to lessen poultry production's feed-related consequences. To begin with, increasing feed efficiency, or lowering the amount of feed required for a given body weight gain or egg production, would cut emissions from both feed production and manure management. Second, it should be feasible to choose feed ingredients that have fewer environmental implications during manufacturing or have a more balanced nutrient content, reducing nutrient excretion such as nitrogen and phosphorus (Steinfeld *et al.,* 2006).

Manure management

Management decisions and the implementation of new manure management strategies have the potential to improve the poultry industry's environmental sustainability (Leinonen and Kyriazakis, 2016). Because significant volumes of methane and nitrous oxide are produced under suboptimal conditions, proper management of bedding and manure stockpiles will reduce GHG emissions (Dunkley, 2011). Anaerobic digestion produces biogas while reducing methane emissions (Gerber *et al.,* 2008). Anaerobic digesters are lagoons or tanks that keep manure in anaerobic conditions so that biogas can be captured and burned for electricity or for flare. By converting methane to CO_2, this minimizes the potential for GHG emissions.

According to Clarisse *et al.,* (2009), ammonia produced by the breakdown of animal wastes could account for 39% of total ammonia in the atmosphere. As a result, reducing the impact of the agriculture sector on global warming requires control of both ammonia and GHG emissions from the cattle and poultry industries. By handling manure as a solid or spreading it on land so it decomposes aerobically and creates little or no methane, and avoiding prolonged litter storage, which can reduce methane emissions, proper manure management reduces GHG emissions while also protecting air and water quality (Dunkley, 2011).

Poultry contributes to climate change by emitting greenhouse gases (GHG) either directly (from manure management) or indirectly (from feed-production activities, conversion of forest into croplands. Emission intensities can be influenced by a combination of factors, depending on the species, system and region in question such as feed conversion ratio (FCR), land-use change, manure management, energy use, and herd/flock structure. Taking environmental issues into account in all management strategies at the farm level can reduce the impacts felt at the level of production. The magnitude of environmental impacts is highly dependent on production practices and specially manures management and some mitigation strategies are includes, farm management, manure management, nutrition management and feed production.

Recommendation

Because of the negative environmental effects of animal agriculture, governments, international organizations, producers, and consumers must give more attention to the role of meat and eggs in society and consider ways to produce these goods without harming the environment. In order to reduce GHG emissions, the poultry industry must continue to work on improving efficiency when using fossil fuels. Poultry farmers must constantly pursue innovations in housing technology in order to be competitive and successful while minimizing the negative effects of global climate change.

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