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Impact of climate change on poultry production: A review

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Abstract

One of the major challenges the world is facing currently is the issue of climate change, which is majorly caused by the emission of greenhouse gas that results in warming of the atmosphere, thus poses a threat to agriculture, socio-economic development and feed sustainability. An aspect of agriculture majorly affected by climate change is poultry production. The effect of climate change can be felt by poultry birds due to its range in thermal condition that affects the animal's physiological and behavioural activities. Production in Poultry birds is mostly at its peak under a tolerable heat condition. An understanding of how to control environmental conditions is very crucial to a successful poultry production and welfare. Climate change influences the following aspect of poultry production; chicken embryonic development, growth and production efficiency, egg production and egg quality, meat quality and disease.

Keywords: Climate change, poultry, livestock, heat stress and Agriculture.

Impact du changement climatique sur la production avicole: un bilan

Résumé

L'un des principaux défis auxquels le monde est actuellement confronté est le problème du changement climatique, qui est principalement causé par l'émission de gaz à effet de serre qui entraîne un réchauffement de l'atmosphère, qui constitue donc une menace pour l'agriculture, le développement socio-économique et la durabilité des aliments. La production de volaille est l'un des aspects de l'agriculture les plus touchés par le changement climatique. L'effet du changement climatique peut être ressenti par les volailles en raison de sa plage de conditions thermiques qui affecte les activités physiologiques et comportementales de l'animal. La production des volailles est surtout à son apogée dans des conditions de chaleur tolérables. Une compréhension de la façon de contrôler les conditions environnementales est très cruciale pour une production et un bien-être avicole réussis. Le changement climatique influence l'aspect suivant de la production de volaille; développement embryonnaire de poulet, croissance et efficacité de la production, production et qualité des œufs, qualité de la viande et maladies.

Mots clés: changement climatique, volaille, bétail, stress thermique et agriculture.

Introduction

A global challenge faced by the world at large is the issue of climate change, which is majorly caused by the emission of greenhouse gas that results in warming of the atmosphere (IPCC, 2013). The impact of climate change is felt around the world, this include increase in temperature, changes in rainfall timing and pattern, changes in seasons (longer summers), increased climate variability (drought, heat waves, floods, land slide), tsunami and other extreme weather events (IPPC 2007). A change in climate is a natural occurrence which takes place concurrently on different time scale, in respect to the variation over

time of the global climate or local climate which may be a trickle-down effect of both natural forces and human activities (FAO, 2009; Irivboje *et al*., 2019). Agriculture and socio economic development is greatly threatened by the challenge of climate change (Niang *et al*., 2014). Africa contributes the least greenhouse gas emission when compared to other developed countries, yet the effect of the climate change will be most felt in this continent, this is largely due to the low infrastructure to cope with the challenge that comes with global warming (Abioja and Abiona, 2020). All human live and activities are affected by the change in climate, a major aspect of this is agriculture. Due to the rising population all over the world, there is an increased pressure on agricultural products to meet demand, this sector is faced with climate issues ranging from; degraded soil, erosion, heat stress and the ongoing build-up of greenhouse gases in the atmosphere that will affect ecological and growing condition of plants and animals (Rosegrant *et al*., 2008). Poultry production is an important subsector of agriculture which plays a vital role in the livelihood of most rural dwellers in Africa (Ayo-Enwerem *et al*., 2017a). They are good converter of feed to egg within a short time and serve as a source of income (Ahaotu *et al*., 2019a). The effect of climate change can be felt by poultry birds due to its range in thermal condition that affects the animal's physiological and behavioural activities. Production in Poultry birds is mostly at its peak under a tolerable heat condition (Ayo-Enwerem *et al*., 2017a). A reduction in ambient temperature result in need for feed with higher energy than in a thermos neutral zone. This result in a less efficient conversion of feed to meat having its impact on the health of the birds and productivity (Olanrewaju *et al*., 2010). Global disease distribution is mostly altered as a result of climate change which in turn encourages outbreak of disease which on every occasion affects poultry output (egg and meat production) and also increase the cost of production (Guis *et al*., 2011). Change in the pattern of rainfall and increase in relative humidity also provides a helpful environment for breeding of parasites that causes outbreak of different diseases (Elijah and Adedapo 2006). An understanding of how to control environmental conditions is very crucial to a successful poultry production and welfare. Therefore, this article aims at reviewing some of the impact of heat stress on poultry and to examine ways to mitigate the effect of seasonal fluctuations on poultry productivity.

Causes of climate change

Climate change can be said to be a long term shift in the statistics of the weather, it could be as a change in the climatic norms such as the expected temperature and precipitation for a given place and time of the year from one decade to the next (Atehmengo *et al*., 2014). The change in climate experienced in the 21st century mostly emerge as a result of greenhouse gas emission, this is due to different forms of human activities over the years, ranging from fuel combustion, urbanisation, deforestation, industrialisation and so on (Upreti, 1999). Climate change can be said to be a threat to lives all over the world due to its variation in solar energy, precipitation and temperature. This invariably has its impact on water resources, coastal regions, freshwater habitats, agriculture, and livestock, melting of snow-covered mountains and increase in climatic events such as landslides, floods and desertification (Koirala and Bhandari, 2019). Climate change is also caused by a number of factors;

Greenhouse gas

The greenhouse gas is of vital importance in the earth climatic cycles. As the sun rays hits

the planet, some of the energy is absorbed while the rest of the energy and heat get reflected into the space. The greenhouse gas is responsible for the trapping of the atmospheric energy and heat and sends it back to the earth which eventually contributes to the global warming (NASA 2019; Terrapass 2020).

Agriculture

Agricultural activities been carried out at different parts of the world is not without its impact on the changing climate. Different forms and types of agricultural activity such as deforestation, in places like the amazon to the raising of different types of livestock contribute to the proportion of the greenhouse gases trapped in the atmosphere (Terrapass 2020).

Human activity

Humans all around the globe are the major contributor to greenhouse gas emission. According to the environmental protection agency, most of the greenhouse gas which is responsible for global warming results from different human activities such as burning of fossil fuel for use of electricity and transportation (in form of trucks, cars, trains, planes) which emit the largest percentage of carbodioxide (CO_2) to the atmosphere thereby remaining a significant cause of climate change (Terrapass 2020).

Effect of climate change on livestock production

Farm animals are most especially affected with the current change in climate resulting into global warming. Heat stress resulting from the global warming has been reported to have a significant effect on livestock production in many parts of the world (Koubkova *et al*., 2002). Increase in temperature due to the changing climate may result in thermal heat stress in most farm animals, this reduce feed intake, lower feed conversion rate, lower immunity, which invariably have effect on growth and productivity of farm animals (Rowlinson, 2008). Decrease in temperature, mostly in the temperate region causes metabolic acclimatization, concentration of plasma corticosteroids and circulating non-esterified fatty acid (NEFA), thereby reducing performance in farm animals (Alvarez and Johnson, 1973; Young, 1981; Broucek *et.al.,* 1987; Birkelo *et al.,* 1991; Nonnecke *et al.,* 2009).

Change in climate impact the availability and quality of feed and grains supply, change in disease and pest pattern, animal health, growth and reproduction (Smith *et al*., 1996). According to Baker and Viglizzo, (1998) any alteration in the pattern of rainfall and temperature results in the distribution of parasites and diseases into new regions this may invariably lead to decrease in the productivity of livestock and in some cases mortality might occur.

Effect of climate change on poultry production

Poultry farming is of major importance in most rural households in Nigeria. Poultry birds are of great economic importance in their supply of eggs, meat, raw materials (feathers, waste products), source of income and employment to human (Ayo-Enwerem 2017a, b) . Poultry also helps in bridging protein malnutrition in most developing nations of the world, especially in Nigeria (Is-Haaq *et al*., 2018).

Climate change has its effect on poultry flocks, this is due to the thermal conditions that affects the bird physiological and behavioural activities (Ayo-Enwerem 2017a). Performance and survivability of poultry birds is influenced by environmental conditions such as ambient temperature, relative humidity and light at a given time (Pragya, 2014). Ahaotu *et al*. (2019) reported that when ambient temperature is raised above 34^0Ce, the mortality will be increased in birds. Change in climate resulting in seasonal fluctuations results in panting in birds thereby resulting in dissipating of excess heat from the birds. Increase in ambient temperature can have a

devastating effect on broiler chicken. This interferes with the comfort of the birds and suppresses production efficiency (Okonkwo and Ahaotu, 2019). When there is a change in temperature, poultry bird exhibit different behavioural and physiological changes which enable them to adjust their heat balance to the environment (Bhadauria *et al*., 2014). As ambient temperature increases, chicken spends more time in drinking than eating, and spend more time spreading out their wings to regulate their body temperature, spends less time walking around and more time resting (Mack *et al*., 2013).

Poultry farmers rely mostly on cereal grains such as soy beans, maize, sorghum and so on, availability of this feed grains to poultry farmers have also been greatly impaired by the change in climate. This has put a level of pressure on the poultry industry in the tropics. Due to change in the pattern of rainfall, and increase in temperature, planting season have invariably been altered and thereby affecting production and availability of this grains to the poultry farmers as at when needed (Adesiji and Baba, 2013). Climate change can be said to influence poultry at different stages of production, this include;

Chicken embryonic development: the increase in environmental and ambient temperature resulting from the change in climate contribute adversely on embryonic growth of poultry birds. Yalcin and Siegel (2003 and 2005) reported that heat stressed embryos have low lungs weight and a shorter face length, this results in unsteady gaits and weak birds. Heat stress from the environment and incubation results in retarded embryonic and post hatch chick development (Deeming and Ferguson 1991; Lourens *et al*. 2001). Increase in temperature and humidity will give a good breathing environment for bacterial and fungi growth (Adejoro 2017). According to Lourens *et al*. (2005) a rise in incubator temperature during incubation of poultry eggs result in adverse effect on the post hatch development of the chicks. Embryos are reported to have a thermal homeostasis at 37.8^0C, this produce good and quality chicks at hatch, any deviation from the temperature will accelerate the growth of the embryo's initially, but later embryonic development is decreased this is due to the limited metabolic process by insufficient exchange of oxygen (Rahn *et al*., 1974; Lourens *et al*., 2005).

Growth and Production Efficiency: Increase in temperature reduce the voluntary intake of feed in poultry bird, this is a mechanism to reduce the endogenous heat generated from metabolism of the feed (Khan and Sarda, 2003). The reduction in feed intake invariablly depresses growth rate and production efficiency (Sahin *et al*., 2001). As the environmental temperature increases, the birds are compelled to maintain a balance between heat production and heat loss, this give rise to reduction in feed intake and increase in water intake. According to the report of Bhadauria *et al* (2014) for every 1^0C increase in temperature, feed intake is reduced by 5% by the birds, this will invariable affect growth and body weight gain. Also a report by (Bonnet *et al*., 1997; Zhou *et al*., 1998) stated that heat stress leads to decreased plasma protein and calcium level and reduction in dietary digestibility.

Egg production and Egg quality: when the temperature become intolerable for the birds, heat stroke can occur resulting into culling and mortality of the birds, thereby reducing production of eggs per laying flock (Ayo *et al*., 2011). Increase in the ambient temperature significantly reduced the hen-day egg production of the heat-stressed flock (Abd-Ellah, 1995). Egg quality both internal and external has also been reported to be affected by temperature due to climate change, this can be attributed an imbalance in calcium-estrogen

relationship and lowered Haugh unit of the albumen (Mahmoud *et al*., 1996; De-Fariara *et al*., 2001). Increased environmental temperature reduced yolk size, optimum calcium deposit in the egg shell and albumen consistency (Mahmoud *et al*., 1996).

Meat Quality: climate change is characterised with change in rainfall pattern and increase in temperature, when there is decrease in temperature due to increase in rainfall, birds needs more energy to maintain body temperature, however, when there is increase in temperature, energy and fat requirement of birds reduces (Soliman and Safwat, 2020). Aminonity of glycerine and proline in carcass tissue is reduced due to increase in temperature. Heat stressed bird carcass shows colouration, dry muscle, increase in blood density and roughness of the skin (Soliman and Safwat, 2020).

Disease: global distribution of disease is relatively altered with change in climate (Uzoma *et al*., 2019). Insect vectors, increase transmission cycles, importation of vectors and animal reservoirs are characterised with increase in temperature (Gilbert*et al*., 2008). Some infectious disease such as infectious bronchitis, Newcastle disease, infectious bursal disease and avian influenza strive when the weather condition turns cold, this significantly affects poultry performance and results in economic loss (Alice Mitchell, 2017). When the weather turns cooler due to change in pattern of rainfall, the birds hurdle together in close proximity, this increase transmission of disease among the flock (Alice Mitchell, 2017). Hot temperature on the other hand increases the problem of respiratory disease in poultry.

Ways to mitigate the effect of climate change on poultry production

Feeding strategy: feed restriction is one method used to reduce the endogenic heat production of poultry birds and minimize mortality, feeds are given to birds during the cool hours of the day (Abhu-Dieyeh, 2006). Uzum and Toplu (2013) observed that feed restricted for proximately 8hours a day during the hot period improves feed efficiency and shortens tonic immobility in broiler chicken. Also the addition of water to chicken feed helps increase water intake during the hot season, the addition of water to poultry feed helps reduce viscosity in the gut aiding a faster passage of feed substances (Syafwan and Kwakkel, 2011). According to (Khoa, 2007: Moritz *et al*., 2001) giving wet feed to broiler chicken helps improve feed intake, body weight gain and weight of gastro-intestinal tract.

Breeding: breeding of genetically improved birds that can tolerate tropical weather condition in the phase of a changing climate is of utmost importance. Breeding animals/birds that are heat tolerant, disease resistance and improve their production and growth rate is a way of mitigating the effect of the climate (Henry *et al*., 2012; Rowlinson, 2008).

Housing and environmental modification: when humidity is increased, evaporative loss due to increase in temperature is reduced, according to Lin *et al*., (2005) and Sinha *et al*., (2017b), temperature and relative humidity of the surrounding environment influences the cooling mechanism of the birds. The use of coolers such as fans, cooling pad, static pressure controller in the pen house helps mitigate the effect of the increase in temperature on the birds (Sinha *et al*., 2018). Housing system should be constructed in an orientation to allow for good ventilation within the pen. Proper ventilation allows for ease management of heat stress and removes moisture loaded air from the poultry house (Butcher and Miles, 2012; Ranjan 2019).

Conclusion

Climate change has a close direct and indirect effect on livestock and poultry

production. Change in temperature affects all aspect of poultry production. Heat stress adversely affect commercial poultry production by reducing feed intake, body weight gain, reduced egg production and increased mortality rate. However, to reduce the lasting effect of climate change on poultry bird, improved animal breeding should be looked into to produce birds that are genetically adaptable to the heat stress in the tropics and can still perform optimally.

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