Influence of climate change on the spread Newcastle Disease in Africa. A Critical Literature Review

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Dr. Alfonso Mwamberi

School of Environmental Sciences, Egerton University

Corresponding author's email: journals@carijournals.org

Abstract

Purpose: Newcastle Disease is a disease that is virulently caused by a form of avian Paramyxovirus type-1 virus that affects the respiratory systems of wild birds and poultry. The overall objective of this study was to examine influence of climate change on the spread Newcastle Disease in Africa.

Methodology: The paper used a desk study review methodology where relevant empirical literature was reviewed to identify main themes and to extract knowledge gaps.

Findings: This study concluded that that farmers should be encouraged to keep poultry chicken depending on their capacity. Thus, there is a need to capacitate farmers' knowledge and participate in decision-making. Most of the adaptation measures can reduce negative impacts of climate change such as improved breeding, use of improved feedings, and burying the infected chicken. However, adaptation was taken into account but there were some challenges faced by farmers such as high cost of vaccinations; inconsistent forecasts of Newcastle Disease spread; lack of training; lack of enough funds; lack of information facilities; drug resistance; ignorance of farmers; culture and misconceptions. Finally, farmers should take more precautions of using vaccines against Newcastle Disease.

Unique Contribution to Theory, Policy and Practice: This study recommended that the national government should devolve and set up weather stations at local levels to help the community monitor and forecast changes in temperatures and rainfall to help them take precautions against adverse climatic events, known as a precautionary principle for community preparation. The devolved and national governments are urged to strategize and provide extension services to farmers periodically to create awareness and technical guidance on dealing with Newcastle disease such as handling and taking hygiene precautions.

Keywords: *Influence, Climate Change, Spread Newcastle, Disease, Africa.*

INTRODUCTION

Newcastle disease (NCD) is a vital concern to most poultry farmers in many parts of the world especially rural areas of developing nations (Wong et al., 2017). Richard et al., (2017) reported that sensitization of farmers about vaccines would increase the number of flocks reared and therefore determine market prices. Poultry farmers perceive climate change as the most threat to their chicken production (Alade & Ademola, 2013). However, there are different types of Newcastle Diseases around the globe and hence Newcastle Disease virus is the most constraint that affects chicken production rather than other diseases in the world like Gumboro (Sultan et al., 2020). It is better to put precautions against this virus to help minimize its spread and the resultant threat to farmers in most African households to increase poultry and wild birds production (Rauw et al., 2010). .Rains during the wet seasons have become unreliable and significantly reduced over time (Bhuyan et al., 2018). The number of days rains are falling have declined from 60 to 30 days during short and wet rainy seasons in some parts of the world where January and February have indicated a prolonged reduction (Bhuyan et al., 2018), leading to lower amount of rainfall during these seasons.

A study in Libya by Ageena et al., (2014) showed that rainfall has intensified within the country especially coastal regions, and the rainfall is expected to increase erratically, causing disastrous floods. On the other hand, Kenya has recorded a 50mm annual reduction of rainfall and an increase of 1°C in temperature in some parts of the country such as the Thika River Basin since 1960 (Maina & Messo, 2017), and the study further suggested that rainfall would keep fluctuating in the next 30 years. There has been an annual mean increase of temperature at the rate of 0.33ºC per decade in Western and Central Ethiopia (Yang et al., 2020), and it is expected to rise in the coming decades. Unpredictable and fluctuating rainfall trends have frequently resulted in floods and 13 droughts accompanied by disastrous landslides and prolonged dry spells that lead to famine and hunger (Gebrechorkos et al., 2020) In Africa, climate variation is a critical issue affecting livestock production (Shewmake et al., 2008).

Poultry farming of diverse types and different ages, sex, phase of production, and reproduction have been greatly affected by climatic variations (Alade & Ademola, 2013). According to the study by Miller et al., (2007), Chickens cannot endure high temperatures, erratic rainfall, and high humidity irrespective of their different stages of life. When there is no moisture absorption in the breathing system of chicken, birds tend to breathe quickly. Likewise, when there is high ambient temperature, birds use moisture from their respiratory tract causing them to pant. The panting makes it possible for birds 2 to increase airflow over the mucous membrane and hence eradicate heat from the body. Normally, sweating is not the process of heat elimination in birds as perceived in humans (Dortmans, 2011).

Chende (2012) researched on indigenous chicken in some parts of Ethiopia. The research study established that rainy days were upsetting to the breeder hens. Enhanced rainfall and moisture escalated the disease occurrences in poultry and livestock, leading to minimal production. Poultry

plays a key role in the lives of the poor rural communities in developing countries. In Kenya, both hybrid and indigenous poultry are reared, where indigenous poultry accounts for a significant portion of the economy and is a source of income to small-scale farmers (Kingori et al., 2010). Most farmers in rural areas rear chicken because the capital required is low and affordable due to cheap household labor.

Range Indigenous Chicken (FRIC) plays an important role in improving the nutritional status and boosts the income for most rural households (Henning et al., 2013). The chicken provides proteins in meat and eggs to the world's population as they are majorly reared as food supplements (Enahoro et al., 2019 & Kingori et al., 2010). Many farmers keep poultry as the simplest investment since its primary importance is to support households whenever they are in financial crises, such as getting medicine, clothing, and school fees when needed. More benefits related to chicken rearing are controlling pests, providing farm manure, traditional ceremony contributions, cleanliness, and hygiene as FRIC feeds on leftover foods (Chende, 2012). Despite their importance, Free Range Indigenous Chicken face many challenges. These include predation by snakes and birds of prey, poor housing, poor nutrition, climate variability, attacks by pests and diseases (Alade & Ademola, 2013).

The climate strongly determines the distribution of disease vectors, their transmission, and evolvement and can 3 influence factors related to the emergence of poultry diseases and birds response to the conditions. The Newcastle disease (ND), which is caused by Avian Paramyxovirus Type 1 (APMV1), is a significant challenge for poultry farmers and producers worldwide (Sultan et al., 2020). The disease can either generally be directly or indirectly influenced by weather patterns and climate change. For example, the distribution and change in climatic patterns proportionately affects the Newcastle diseases. The outbreaks are generally associated with alternating heavy rains, persistent drought, and continuous rising temperatures (Brown & Bevins, 2017). High temperatures are associated with the development of some serious pathogens or parasites that have a life cycle outside the animal host. This has impacts of shortening the generation times and increasing the numbers of the generations per year, leading to an increased number of pathogens and parasites.

Statement of the Problem

Indigenous breeds of chicken in Kenya form about 76% of the total poultry population and produce about 55% and 47% of the total meat and eggs, respectively. Despite this contribution, poultry production is constrained, especially among small-scale farmers, due to Newcastle disease. Different communities and households rear Free Range Indigenous Chicken for commercial or subsistence purposes. However, numerous challenges affect the rearing of Free Range Chicken in most parts of the world, including the high cost of farming inputs and climate variability, which is an excellent determinant of poultry production and health status.

To improve the productivity of Free-Range Chicken amid climate variability, farmers need to be guided by scientific information and effective interventions to reduce the spread of the virus causing Newcastle Disease. Even though there are many mechanisms of adapting to these phenomena, such as developing new vaccines against the virus, quarantine of the chicken to limit the spread of the virus, and using of traditional herbs, the attempt to adapt is still at early stages in most parts of the developing nations. There have been many research studies about the cause of Newcastle Disease and its effects on Free Range Chicken around the world by various scientists. However, there is still the existence of scanty information about the relationship of climate variability and Newcastle Disease. This study will therefore examine influence of climate change on the spread Newcastle Disease in Africa. A critical literature review

Objective of the Study

The overall objective of this study was to examine influence of climate change on the spread Newcastle Disease in Africa. A critical literature review.

Significance of the Study

The most vital impacts of climate variability experienced in the agriculture sector, are in poultry farming, crop farming, and livestock rearing. Therefore, these changes in climate patterns are linked to human livelihoods and economic growth of well-being (IPCC, 2012). This phenomenon of climate and economic dynamics poses human uncertainty for present and future generations. Thus, there is a desire to research and study the connection between climate and livelihoods on local, regional, and international scales to grasp and solve complex socio-economic problems within our societies. However, the transfer of these traditional interventions within our community to the current and future generations using the trendy science of trans-disciplinary approach and intergenerational equity is necessary.

In conclusion, it is better to integrate community-based methods to understand these concepts of climate variability and poultry farming, which will finally advance our development agendas (Qian-qian et al., 2015). The research study gives a fundamental outlook on the comprehensive and valuable guide into the relevant agencies that can be involved in the research and policy practice, especially the government embarking on projects that would exploit the benefits of poultry farming in Kenya to improve livelihoods (Odey et al., 2018). Updating farmers on positive precautions taken concerning the outbreak of the diseases is necessary. The scientific information from this study would be important to livestock health workers and poultry farmers on both local and international scales. Lastly, the findings of this study would inform the decision-making of poultry vendors, traders, and consumers and provide policy makers with vital information to process better management policies of poultry farming.

LITERATURE REVIEW

Influence of Climate Variability on the Spread Newcastle

Disease Changes in weather patterns such as humidity, rainfall, sunshine, and temperature influence the spread of Newcastle Disease (Richard et al., 2017). However, the linkage of the spatial and temporal distribution of climate variability is significantly correlated to the outbreak of Newcastle Disease (Dimitrov et al., 2016). Studies by Nyaiyo, (2014) at Suneka in Kenya statistically found that the death of chicken due to Newcastle Disease was correlated to weather patterns during August, December, July and January at a significance level of $p < 0.05$. Climatic conditions affect poultry and wild birds' behaviors, physical mobility and physiological modification hence are vulnerable to transmission of the Newcastle Disease virus (Alade & Ademola, 2013). The same results were empirically noted by Tilakasiri, (2015) which showed that high relative humidity, high temperatures, and heavy rains were related to the mortality rate of chicken and the spread of Newcastle Disease in the Ilorin area of Nigeria.

Social-Economic Effects of Newcastle Disease

Newcastle Disease has effects on households' income during the outbreak periods (DiFalco et al., 2012). Studies by Henning et al., (2013) in Myanmar showed that rural farmers of chicken and wild birds would lose US$30.7 to US$167. Without using vaccines against the effects of Newcastle Disease. However, the use of vaccines to withstand Newcastle Disease also cost farmers but not as much as deaths of chicken could have cost. Mu et al., (2011) evaluated the economic loss of Newcastle Disease due to climate change, the study found that an increased probability of outbreak would result in loss of US$106 million in China and US$28 million in the United States in the year 2011-2030. Newcastle Disease is related to social factors such as age, level of education, and experience, these factors have the probability to reduce or increase the effects of climate variability depending on the farmers' capacity (Wolfert et al., 2017).

Existing Adaptation Strategies to Control Newcastle Disease

Poultry scientists have come with different vaccines to curb the effects of Newcastle Disease amidst climate variability (Rauw et al., 2010). However, there are many other measures of adaptation used by farmers against Newcastle Disease instead of vaccination. This included using traditional herbs, poultry quarantine, improved chicken feeds, and rearing of improved chicken breeds that are immune to Newcastle Disease (Dortmans, 2011). Rural farmers are encouraged to control Newcastle Disease by use of husbandry practices to limit the spread, this method of adaptation is not costly as other methods, therefore, reduces economic losses. Lv et al., (2019) in the South of China explored the impact of herbal medicine visa vise vaccine medicine on Newcastle Disease, the results showed that chemical vaccines were more effective than herbal medicine and therefore encouraged farmers to use vaccines as a way to control Newcastle Disease. A study in Northeastern Madagascar suggested that vaccination of chicken would cover at least 40% in less than 5 years, double the chicken population in the area.

Empirical Review

Kipchumba (2022), conducted a study on influence of motivational climate and goal orientation on attitudes towards doping among athletes in Elgeyo-Marakwet Count, Kenya. Cross-sectional survey design was used and data was collected from athletes (N=323) from Elgeyo-Marakwet County, Kenya who were recruited through stratified random sampling. An adapted version of the Perceived Motivational Climate in Sport Questionnaire (PMCQ-2) was used to assess the athletes' motivational climate, while athlete's goal orientation was assessed using the Task and Ego Orientation in Sport Questionnaire (TEOSQ). Based on responses to a five-point Likert scale, results of descriptive analyses showed the following: mastery climate; 4.17 ± 0.62, performance climate; 2.88 ± 0.62, task-orientation; 4.14 ± 0.65, ego-orientation; 3.07 ± 0.79 and doping attitude scale; 2.32 ± 0.70 (Mean ± Standard Deviation). Correlational analysis indicated significant inverse relationship between mastery climate and doping attitude (rho = -.242; $p < 0.001$) and a significant positive correlation between performance climate and doping attitude (rho = .362; $p < 0.001$) in motivational climate. The study presented a conceptual gap as it focused on influence of motivational climate and goal orientation on attitudes towards doping among athletes in Elgeyo-Marakwet Count, Kenya while our study will focus on ambient temperatures on dairy production in Africa.

Nkonge (2022) conducted a study to evaluate the ability to adapt socially, physically, and economically to climate variability among the Ngaremara pastoralists in Isiolo County. The study used a cross-sectional research design. Systematic, simple, and purposive sampling methods were used to sample the population. Data presentation is in the form of tables, figures, and graphs. The expected output was that low socioeconomic development among Ngaremara pastoralists in Isiolo County increased vulnerability to climate variability. The study proves that there is reduced adaptive capacity and their traditional methods to cope with climate variability are futile. Their living standards are deficient because their livelihood sources solely rely on pastoralism, which has been affected by climate variability. Moreover, fluctuating rainfall of between 250mm and 400mm and an annual average temperature of 290C have exposed pastoralists to drought, floods, famine, and pastoral conflicts. Still, they are willing to adopt new coping strategies for climate variability. The impact of the study will enable informed decision-making by external agencies such as policy makers, NGOs, Isiolo County Government, and the community to improve the adaptive capacity to climate variability by developing coping strategies, creating information avenues such as Early Warning Signs, and enhance development by introducing various projects to diversify livelihoods. The study was done in Isiolo County presenting a geographical gap while our study will be done in Africa.

Koech (2021) conducted a study to examine rainfall and temperature trends in the county in the period 1989 to 2019. It also determined the extent to which climate variability has affected rural roads used for tea transport. It also assessed tea farmer's perception on climate variability effects on rural roads infrastructure and greenleaf transportation. By use of Yamane's 1967 formula, 398

farmers were obtained. The study found that climate significantly varied between 1989-2019. Heavy rains occur periodically that damage rural tea roads thus impacting negatively on tea transportation. Rural roads should continuously be maintained to address uncertainties. There is need, therefore, for heavy investment of emergency funds for repair and maintenance of rural tea roads based on climate variability and heavy rain return period pattern. A comparative study should be done in other counties to understand climate variability on rural road infrastructure within those counties.The study presented a conceptual gap as it focused on rainfall and temperature trends in the county in the period 1989 to 2019 while our study will focus on influence of ambient temperatures on dairy production in Africa,

Nyirandorima (2021), conducted a study on to evaluate the socio-economic factors that determine the effects of climate change on rice production and consequently how level of farmers" perceptions and awareness determined their choice of adaptations strategies. Specifically, the study analyzed climate trend of Bugarama from 1981-2017, assessed the extent of awareness among rice farmers about climate change, identify the climate-change adaptation strategies adopted by rice farmers, and determined the factors that influence the adoption of adaptation strategies in rice production, finally the study calculated the marginal cost for farmers" rice production. The study was conducted in Bugarama Wetland, Rwanda and stratified sampling technique was employed. The Bugarama area was stratified into administrative villages and farmers were non-randomly chosen regardless of their scale of farming where the rice agriculture production cooperative of 1600 farmers operating their agro-business with a sampling size calculated of 320 farmers; the Descriptive survey design was used in this study with quantitative and qualitative based on primary data; A stratified sampling technique was employed to systematically select farmers during data collection. The results deduced that the level of education ($p =0.019$) extension access ($p=0.001$), market distance ($p=0.002$) and rice income ($p < 0.001$) had a high probability of influencing farmers" perceptions about climate change thus the need to adapt. Based on outcome model, results showed that extension access ($p < 0.001$), household size ($p= 0.098$), market distance ($p= 0.047$), rice income ($p =0.032$), farmers-to-farmers ($p < 0.001$) and effects of climate change on rice ($p=0.038$) had a greater probability of influencing farmer's choice of adaptation method used to improve rice yields. The results showed that farmers a profit margin 0.296. To conclude, the study found that access to informational facilities, rice income, influenced farmers" perceptions while extension access, rice income, market distance, farmers-to-farmers contact and effects of climate change on rice yield strongly had a probability of determining farmers" choice of adaptation. The study presented a methodological gap as it used descriptive research design while our study will use desktop review approach.

Otieno (2019), conducted a study on the effects of climate change on agricultural productivity in Kenya. The study adopted time-series data on all the variables under study. The study employed Ricardian Regression Model to analyze time-series data. A diagnostic research design was employed to carry out the study as it explored secondary sources of data which was analyzed using

multivariate regression model and Augmented Dickey Fuller (ADF) was carried out to check the stationary of the data. The study found out that temperature and relative humidity significantly affect agricultural productivity. Relative humidity was found to be positively related to agricultural productivity, temperature has negative relationship. The study recommended that government should sensitize the farmers on the need to carry out smart agriculture to reduce losses as a result of climatic change. The study also found out that rainfall positively related to agricultural productivity. Therefore, the study concluded that indeed climate change affect agricultural productivity in Kenya. The study however presented a methodological gap as it utilized diagnostic research design while our study will utilize desktop review approach.

Kariuki (2017) conducted a study to establish the key areas of climate change addressed by the current Kenya's secondary school formal curriculum; to establish the extent to which implementation of the curriculum contributes to awareness of climate change among teachers and students and to evaluate effectiveness of curriculum developers in infusing climate change content into Kenya's secondary school curriculum. To achieve the set objectives, the study adopted a descriptive survey research design. Analysed data established that sampled subjects had an aggregate variation ratio of 0.44. A statistical test established that the chi-square value was greater than the significant value, that is 0.567>0.495. A conclusion was made that climate change content in the sampled subjects was inadequate. On the relationship between implementation of curriculum and awareness among teachers, the chi-square value was greater than the significant value, 0.794>0.659, and therefore the relationship was not significant. However for students a significant relationship was established with likelihood ratio being less than the significant value, 0.196>0.658. Finally the study established that 63% and 13% of sampled curriculum developers rated the curriculum as poor or very poor respectively. This implied that infusion of climate change content into the curriculum was not been effective. The study presented a contextual gap as it focused on schools while our study will focus on new castle disease

Kiarie (2016), conducted a study that evaluated trends in rainfall and temperature between1983 and 2013, assessed how these trends of climate variability have affected farmers' perception in climate variability and also explored small-scale farmers' adaptation strategies. Results of the study established that small scale farmers in Kijabe experienced climate variability in the period 1983-2013. The results of this study established a positive relationship between temperature variation and adaptation by small scale farmers in Kijabe. Small scale farmers who detected an increase in temperature were more likely to adapt compared to those who have not detected any increase in temperature (r= 0.015, p<0.020). The study further showed that small scale farmers who detected an increase in rainfall were less likely to adapt compared to those farmers who detected a decreased in precipitation (r= -0.014, p<0.001). The study presented a conceptual gap as it focused on trends in rainfall and temperature between1983 and 2013 while our study will focus on influence of ambient temperatures on dairy production in Africa.

METHODOLOGY

The study adopted a desktop literature review method (desk study). This involved an in-depth review of studies related to influence of climate change on the spread Newcastle Disease in Africa. Three sorting stages were implemented on the subject under study in order to determine the viability of the subject for research. This is the first stage that comprised the initial identification of all articles that were based on examining influence of climate change on the spread Newcastle Disease in Africa. The search was done generally by searching the articles in the article title, abstract, keywords. A second search involved fully available publications on the subject on influence of climate change on the spread Newcastle Disease in Africa. The third step involved the selection of fully accessible publications. Reduction of the literature to only fully accessible publications yielded specificity and allowed the researcher to focus on the articles that related to influence of climate change on the spread Newcastle Disease in Africa which was split into top key words. After an in- depth search into the top key words (influence, climate change, spread Newcastle Disease, Africa) the researcher arrived at 7 articles that were suitable for analysis. This were findings from:

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SUMMARY, CONCLUSION AND RECOMMENDATIONS

Conclusion

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Recommendations

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