

Effect of Climate Change on Poultry Production in Maiduguri Metropolis, Borno State, Nigeria

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ABSTRACT

The study examined the effect of climate change on poultry production in Maiduguri Metropolis, Borno State Nigeria. The study described the socio-economic characteristics of the poultry producers in Maiduguri metropolis, identified the climate change factors that affect poultry production, estimated the effect of changing climate conditions on poultry feed availability and quality and identified the mitigation strategies against climate change factors that affect poultry production in the study area. Primary data were collected through questionnaires and oral interviews. The secondary data were obtained through research paper and publications. A two-stage random sampling procedure were employed to select four wards with high number of poultry farmers, then 20 poultry farmers were randomly selected, resulting in a total of 80 respondents. Both descriptive and inferential statistics (Multiple regression analysis) were used to analyze collected data. Results of the study revealed that 70.2% of the respondents were female and 25.0% were male. Also majority of the respondents (70.2%) were at the age range of 36-45 years, 76.2% were married, while 53.6% had been in poultry farming for about 6-10 years. Majority of the respondents (61.9%) agreed that they observed changes in weather patterns in the study area. Furthermore, majority of the respondents (69.0%) encountered mortality of birds due to climate related factors. Ambient temperature, rain fall, disease and mortality are the climatic factors that influence output of poultry. The mitigation strategies adopted in response to climate change impacts, were changing breeds, improving ventilation and cooling systems, adjusting feeding practices, and increasing access to clean water.

Keywords: Climate Change, Maiduguri Metropolis, Poultry Farming.

INTRODUCTION

Climate change refers to the gradual increase in the Earth's average surface temperature caused by human activities such as burning fossil fuels, deforestation, and industrial processes. Climate change refers to a significant long-term change in the average weather patterns that have come to

define the Earth's local, regional and global climates. This increase in temperature is leading to a range of environmental impacts such as sea level rise, more frequent and intense natural disasters, and changes in weather patterns (Intergovernmental Panel on Climate Change, IPCC, 2021). According to the Intergovernmental Panel on Climate Change (IPCC), global temperatures have risen by one

Effect of Climate Change on Poultry Production in Maiduguri Metropolis, Borno State, Nigeria

degree Celsius since pre-industrial times, and this trend is projected to continue without immediate action to reduce greenhouse gas emissions (IPCC, 2021). This warming is causing glaciers and ice caps to melt, which is contributing to a rise in sea levels that threatens coastal cities and low-lying islands (National Aeronautics and Space Administration NASA, 2021). Climate change is also leading to more frequent extreme weather events such as heatwaves, droughts, wildfires, and floods, which are causing significant economic and human losses (UN Environment Programme, 2020). Moreover, climate change is causing irreversible damage to ecosystems and biodiversity, which in turn could impact human health, agriculture, and food security

Climate change is affecting biodiversity and ecosystem services, causing species extinction, alteration of habitats, and reduced productivity of agricultural lands, forestry, and fishery resources, which are key components of human well-being and economic development. Climate change is causing shifts in precipitation patterns, leading to more frequent and severe storms, floods, and landslides that can cause significant damage to homes, businesses, and critical infrastructure. (IPCC, 2018). Climate change is causing global temperatures to rise at an alarming rate, leading to more frequent and severe heat waves, droughts, and wildfires that threaten public health, infrastructure, and food systems. (IPCC, 2018). The economic cost of climate change is staggering and will only continue to increase with time, as we witness the impacts on agriculture, transportation, energy, and infrastructure (World Bank, 2021). U.S. Environmental Protection Agency (EPA) states that "climate change is one of the most significant public health threats of our time" and that "increases in temperature and changes in extreme weather events are likely to lead to more heat-related illnesses and deaths, poor air quality, increases in waterborne diseases, and more foodborne diseases" (EPA, 2016).

Climate change poses a significant threat to Nigeria's economy, natural resources and human development. Nigeria's climate is already changing, with increasing frequency and severity of extreme weather events such as droughts, floods, heat waves,

and sea-level rise. One of Nigeria's most significant climate change impacts is on agriculture, which accounts for up to 70% of employment and 40% of GDP (World Bank, 2021). Climate variability and change are projected to result in a decline in agricultural productivity, particularly in the northern states. This is due to a combination of factors, including reduced availability of water resources and increased frequency and intensity of heatwaves (Obioha, Okoro and Chukwu, 2020). Another significant impact of climate change in Nigeria is on the country's coastal areas. These regions are particularly vulnerable to sea-level rise, storm surges, and shoreline erosion. A study by Olaniran, Adelekan and Fasona, (2019) found that climate change is expected to accelerate shoreline erosion and sea-level rise in Lagos and other coastal cities in Nigeria, resulting in displacement of residents and increased risk of flooding. Additionally, climate change is linked to a range of environmental and health impacts in Nigeria. Air pollution from industrial and transportation emissions is projected to worsen as weather patterns change. Extreme heat events can lead to heat stress and heat-related health issues such as dehydration, exhaustion, and heat stroke (Adelekan, Fasona and Olaniran, 2019). Vector-borne diseases such as malaria are also projected to spread as temperatures increase and rainfall patterns change (Oyebisi, 2017).

Climate change is a significant global issue that has impacted Nigeria in various ways, including unpredictable weather patterns, increased flooding, droughts, and decreased agricultural productivity. According to the Climate Risk Index (2020) Nigeria is ranked as one of the countries most affected by climate change, with extreme weather events causing substantial economic and human losses. According to the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report, climate change impacts will continue to have significant implications for agriculture, forestry, water resources, and human settlements in Nigeria (IPCC, 2014). In a report by the National Bureau of Statistics (NBS), the Nigerian economy lost around 9.44 billion USD to climate change-induced disasters between 2012 and 2016. The report also stated that climate impacts can hinder the achievement of the country's sustainable

Effect of Climate Change on Poultry Production in Maiduguri Metropolis, Borno State, Nigeria

development goals (NBS, 2019). The sixth report released on 20th March, 2023 by the IPCC showed that the year 2023 was the warmest in more than a century and the 10 warmest years in the last decade (2014-2023), as temperature increased by 0.15⁰C more than the last record of 2016 (13.9⁰C) (IPCC, 2023).

Studies have shown that climate change is causing a decline in agricultural productivity in Nigeria, with the potential to exacerbate food insecurity in the country (Ademiluyi, Adeyemo, and Ogunlade, 2019). The changes in temperature, precipitation patterns, and the occurrence of extreme weather events affect crop yields, livestock production, and food security. The effects of climate change on agriculture in Nigeria is climate variability and extreme weather events such as floods, droughts, and storms have become more frequent in Nigeria, leading to crop damage, livestock losses, and food shortages (Amusan, Abaje and Akinbile, 2019). Additionally, changing rainfall patterns and increased temperatures have led to reduced water availability and increased droughts, particularly in the northern region of Nigeria (Enete, Agwu, & Achike, 2018). This has affected the growth and productivity of crops such as maize, sorghum, and millet, which are important staples in the northern part of the country.

According to the Nigeria Climate Change Vulnerability and Risk Assessment Report, climate change has caused a decrease in agricultural production in many parts of Nigeria, with crop yields declining by as much as 30% in some areas (Federal Ministry of Environment, 2013). This has resulted in food shortages, loss of income, and increased poverty among farming communities. Also in the agricultural sector, climate change is affecting crop and livestock production, including poultry production in many parts of the world. The poultry industry is a vital component of the agricultural sector, contributing significantly to the global food supply and economy. Poultry production which is the process of raising domesticated birds such as chickens, turkeys, ducks, and geese for their meat, eggs, or feathers, is an important source of food and income for millions of people around the world and provides essential

protein to the population and generates income for smallholder farmers.. According to the Food and Agriculture Organization (FAO), over 80% of the world's poultry production comes from small and medium-scale farmers. Also poultry provides about 13% of the animal protein consumed globally, and contributes to livelihoods in both rural and urban areas (FAO, 2020). Poultry production has been associated with environmental impacts such as water pollution and greenhouse gas emissions, and climate change-induced factors such as rising temperatures, extreme weather events and changes in rainfall patterns. However, sustainable and responsible management practices can mitigate these impacts (FAO, 2021). The increasing frequency and severity of climate-related hazards pose significant challenges to the sustainability and resilience of the poultry industry. Furthermore, the impacts of climate change on poultry production have consequences not only for the industry but also for food security and the livelihoods of those who depend on it.

Maiduguri metropolis in Nigeria is one of the areas affected by the challenges of climate change in poultry production. The effect of climate change on poultry production in Maiduguri metropolis of Nigeria is a growing concern, as changes in weather patterns can affect the survival and growth of poultry birds. As the region experiences increasing temperatures, shifting rainfall patterns, and more frequent extreme weather events, it is essential to understand the specific challenges faced by poultry farmers in the area and explore possible strategies to mitigate the effect of climate change on their operations. Therefore, there is a pressing need to investigate the effects of climate change on poultry production, identify adaptation strategies and create policies to mitigate and adapt to the challenges posed by climate change. Thus, the study analysed the effect of climate change on the poultry production in Maiduguri metropolis, Borno State in Nigeria.

MATERIALS AND METHODS: The study was conducted in Maiduguri Metropolis of Borno State, Nigeria. The Metropolis is made up of two Local Government Areas Jere and Maiduguri Metropolitan Area and some parts of Konduga and

Effect of Climate Change on Poultry Production in Maiduguri Metropolis, Borno State, Nigeria

Mafa Local Government Areas. It is located on longitude 13° E and latitude 12° N with an approximated land area of 69,436 square kilometers (NPC, 2006). It is the largest city in the North-Eastern region of Nigeria and lies in the Sahel savannah vegetation. The average temperature ranges between 35° C - 40° C and the area is usually cold and dry during the harmattan (strong wind characteristics of the region), with November to January being the coldest months, with a temperature range of 28° C - 32° C. The area has an average annual rainfall of about 647mm per annum with the rainy season covering the months of June to October (Borno State Agricultural Development Programme, BOSADP, 2010).

Its economy is largely based on farming, civil service and trade with a small share of manufacturing. The climate is favourable for the production of several crops and livestock. The region is known for its production of crops such as grains, vegetables, and fruits. Livestock rearing, particularly poultry production, is also a significant economic activity in the area. The effect of climate change on poultry production in Maiduguri metropolis is of great concern. Due to the high temperatures and low precipitation, the region is prone to droughts and food shortages. The changing climate patterns have affected the productivity of poultry farms, leading to low egg production and high mortality rates among the birds.

Primary data were collected through questionnaires and oral interviews. The secondary data were obtained through research papers and

$$Y = \alpha + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + e$$

Where;

Y = output (average=1; low=0)

X₁= ambient Temperature (high =1; low=0)

X₂ = mortality (high=1; low=0)

X₃ = rainfall (high=1; low=0)

X₄ = disease (high=1; low=0)

X₅ = humidity (high=1; low=0)

e = error term

A Priori Expectation

It is expected a priori that the coefficients of rainfall and humidity would be positive while the coefficients of temperature, mortality and disease would be negative.

Effect of Climate Change on Poultry Production in Maiduguri Metropolis, Borno State, Nigeria

publications. Data were collected from poultry farmers in the month of October, 2023. A two-stage random sampling procedure was employed in sample selection. First, a purposive sample of 6 wards in Maiduguri with a high concentration of poultry producers were selected. The wards are Mashamari, Dusuman, Gongulong, Gwange I&II and Shehuri. The purposive selection will help to ensure that the study is conducted in areas where the effects of climate change are likely to be most pronounced. In the second stage, a simple random sampling of 20 poultry producers was conducted from each of the selected areas, resulting to a total of 80 respondents. This will help to ensure adequate representation of different demographics and ensure that the findings can be generalized to the wider population. Both descriptive and inferential statistics were used to analyze collected data. Descriptive statistics such as frequencies, ranks, mean and percentage were used to describe the socio-economic characteristics of the farmers, identify the climatic factors and the mitigation strategies used by the farmers. The inferential statistics used was the multiple regression analysis, which was used to determine the effect of climate change on poultry production.

Multiple regression analysis was used to determine the effect of effect of climate change on poultry output. The variables measured in the model included ambient temperature, mortality, rainfall, disease and humidity. The model used was the binary logit model and presented as follows:

RESULTS AND DISCUSSION: Socio-Economic Characteristics of the Respondents

Table 1 revealed that 70.2% of the respondents were females while 25.0% were males. The result showed

that female are more involved in poultry farming than their male counterparts. There is a gender disparity in poultry farming, with a significantly higher percentage of females being involved in the industry compared to males. This because female farmers in these wards are mostly housewives and are seen as caretakers in their homes with skills suited to tasks like poultry farming in their houses, while men might be engaged in other types of work outside their home. The finding agrees with the findings of Okitoi, Ondwasy and Murekefu (2007), which reported that women were the primary owners of poultry in Western Kenya.

The result further showed that majority of the respondents 70.2% are within the age range of 36-45 years of age. This shows that majority of the respondents are in their active age, hence they have the ability to supply the required labour needed in the production process. The result on marital status showed that majority of the respondents 76.2% were married. This is because most of the farmers are house wives that practice backyard poultry farming. Similar study conducted by Patrick (2017) showed that 71.43% of the heads of households are married. Tenge, de Graaff and Hella (2004) added that this group is the most influential people and decision

makers at both the village and household levels. The group of widows follows with about 22.29% of the heads of households.

On educational level of the respondents, the result indicated that 63.1% of the respondents had tertiary education while 25.0% and 7.1% had secondary and primary education respectively. Thus, all the respondents are literate. This is in line with the findings of Sluis (2007) who found that poultry farmers in Ondo State, Nigeria are formally educated. The findings of the study revealed that 75.0% of the respondents are engaged in poultry farming as their primary occupation. This is probably because the poultry farmers are females who are predominantly at home. Result on farm ownership revealed that 63.1% of the respondents served as both owner as well as manager of their enterprise. This is because they are married women that are managing their poultry farms at home, so they have all the time for their poultry. The result on flock size revealed that 55.6% of the respondents had 1-200 flock size of birds. This suggests that the surveyed poultry farmers may be operating small to medium-scale enterprises, which could have implications for their production capacity, market access, and overall economic viability.

Table1: Socio-economic Characteristics of the Respondents (n = 80)

Variables	Frequency	Percentage (%)
Gender		
Male	21	25.0
Female	59	70.2
Age		
25-35	15	17.9
36-45	59	70.2
46 and above	6	7.1
Marital Status		
Single	6	7.1
Married	64	76.2
Divorced	10	11.9
Educational Level		
Primary	6	7.1
Secondary	21	25.0
Tertiary	53	63.1
Years of Experience		

Effect of Climate Change on Poultry Production in Maiduguri Metropolis, Borno State, Nigeria

1-5 Years	16	19.0
6-10 Years	45	53.6
11-15 Years	19	22.6
Primary Occupation		
Poultry farmer	63	75.0
Student	7	8.3
Business	10	11.9
Farm ownership		
Owner	20	23.8
Manager	7	8.3
Both	53	63.1
Flock Size		
1-200 birds	47	55.6
201-400 birds	17	20.6
401-600 birds	10	11.9
601-800	6	7.1
Other sources of income		
Others	65	77.4
Personal	15	17.9

Source: Field Survey, 2023

Result on the experience of poultry farming revealed that majority of the respondents (53.6%) had been in poultry farming for about 6-10 years. This suggests that there is a considerable amount of knowledge and expertise within the poultry farming community, which could have positive outcomes for the overall productivity, efficiency, and sustainability of poultry farming practices. It also indicates that there is a substantial group of experienced individuals who could potentially serve as mentors or resources for newer poultry farmers, contributing to the overall development and success of the industry. This is in conformity with the findings of Ezihe Ali, and Ivom (2020) who revealed that most (52.5%) of the poultry farmers in Benue State, Nigeria have mean experience of 10 years. It is similar to the findings of Sluis (2007) who found that the average years of experience in poultry production is 9. The results further revealed that 77.4% of the respondents had other sources of income other than poultry farming and 17.9% responded that they had no other source of income other than poultry farming in the study area. This

shows that significant majority of poultry farmers surveyed have additional sources of income beyond poultry farming.

Climate Change Factors that Affect Poultry

Production: Table 2 revealed that majority of the respondents (61.9%) observed changes in weather patterns in the study area. Understanding the impact of changing weather patterns on poultry farming is crucial for developing strategies to mitigate potential negative effects and adapt to a changing climate. The result on Table 2 further showed that majority (57.1%) of the respondents observed health related issues among flocks attributed to climate changes such as heat stress, or diseases, The findings shows that climate change and associated weather patterns have a significant impact on the health and well-being of poultry flocks. High rainfall and relative humidity provides a conducive environment for breeding of parasites that causes outbreak of diseases which invariably reduces egg and meat production (Elijah and Adedapo, 2006).

Effect of Climate Change on Poultry Production in Maiduguri Metropolis, Borno State, Nigeria

Table 2: Climate Change Factors that Affect Poultry Production

Respondents	Frequency	Percentage
Changes in weather pattern		
Yes	52	61.9
No	18	21.4
Not sure	10	11.9
Health issues due to climate change		
Yes	48	57.1
No	14	16.7
Not sure	18	21.4
Mortality due to climate related factors		
Yes	58	69.0
No	10	11.9
Not sure	12	14.3
Estimated percentage mortality		
1-5	16	19.0
6-10	45	53.6
11-15	19	22.6
16 and above	6	7.1

Source: Field Survey, 2023

Also the result on Table 2 also revealed that majority of the respondents (69.0%) encountered mortality due to climate related factors such as extreme temperatures, heavy rainfall, and low relative humidity. Understanding the impact of climate-related mortality on poultry farming is crucial for developing strategies to enhance the resilience of poultry production systems. It underscores the interconnected nature of climate change, animal welfare, and agricultural productivity and highlights the need for comprehensive approaches to address the challenges posed by changing climate patterns. The finding revealed the estimated percentage mortality as the

majority (53.6%) of the respondents experienced mortality within the range of 6-10 flocks, while (22.6%), (19.0%) and (7.1%) experienced mortality within the range of 11-15, 1-5 and 16 and above respectively. High temperature and sunshine intensity many at times results to high mortality of the chickens, low egg production and low feed in take with low production.

Effect of Changing Climate Conditions on Poultry Output: The result of the regression analysis indicated the relationship between the dependent variable (output of poultry production) and the independent variables.

Table 3: Result of Regression on the Effect of Climate Conditions on Poultry Output

Variables	Co-efficient	T-value	Significance
Constant	1.415	3.153	0.002
Ambient temperature (X ₁)	-0.420	-3.586*	0.001*
Mortality (X ₂)	-0.022	-0.233	0.817ns
Rain Fall (X ₃)	-0.206	-2.118*	0.038*
Humidity (X ₄)	0.008	0.075	0.941ns
Disease (X ₅)	0.184	1.702	0.093*
Mortality (X ₆)	0.195	1.677	0.098**
R ²	0.335		
Adjusted R ²	0.280		0.000
F-ratio	6.122		

Effect of Climate Change on Poultry Production in Maiduguri Metropolis, Borno State, Nigeria

Source: Field Survey, 2023, * Significant at 1%, ** Significant at 10%, ns Not significant

The model has an R-squared value of 0.335 and an adjusted R-squared value of 0.280, indicating that the independent variables can explain approximately 33% of the variation in the output of poultry production. The F-ratio of 6.122 is significant, indicating that the overall regression model is statistically significant.

The result shows that ambient temperature, rain fall, disease and mortality are statistically significantly and thus influence the output of poultry production systems, while mortality, humidity, and disease do not show a significant relationship with the dependent variable. These findings can be used to inform strategies for enhancing the resilience of poultry production systems in the face of changing climate patterns. Olawale (2021), studied Climate Change Impacts on Poultry Production in Nigeria, and found out that climate change impacts on poultry production in Nigeria were mainly due to increased temperatures, erratic rainfall, and emergence of new pests and diseases. This resulted in reduced feed intake, decreased egg production, and poor growth of broiler chickens. According to a

study conducted by Lemke Wurbs and Reinsch (2013), on the Climate Change Impacts on Poultry Production found out that climate change can affect poultry production in a number of ways, including altering the distribution of avian diseases, decreasing feed availability, and increasing heat stress on birds. Also Chaudiere, Bastianelli and Leterrier (2017), studied Impact of heat stress on egg production and quality of laying hens, and found out that the heat stress caused by high temperatures and humidity levels can significantly lower the egg production and quality of laying hens. Similarly, prolonged exposure to heat stress can lead to reduced weight gain, poor feed conversion, and increased mortality rates in broiler chickens. These effects can translate into significant economic losses for the poultry industry.

Mitigation Strategies Employed by Poultry Farmers in Response to Climate Change

The farmers employed some mitigation strategies to tackle climate change effects on their poultry farms. The result is presented on Table 4.

Table 4: Mitigation strategies employed by poultry farmers in response to climate change

Respondents	Frequency	Percentage
Mitigation strategies adopted on impact of climate change		
Improved ventilation and cooling systems	25	29.8
Changing poultry breeds that are more resistant to heat or cold	35	41.7
Adjusting feeding practices	12	14.3
Increasing access to clean water	8	9.5
Effectiveness of these strategies adapted		
Very effective	38	45.2
Somewhat effective	32	38.1
Not very effective	10	11.9
Training or support received		
Yes	60	75.0
No	20	23.8

Source: Field survey, 2023.

Table 4 revealed that majority of the respondents 41.7% adopted changing breeds that are more resistant to heat or cold as mitigation strategy on impact of climate change, while 29.8% adopted improved ventilation and cooling systems, adjusting feeding practice and increasing access to clean water as mitigation strategy on impact of climate change

in the study area. Understanding the mitigation strategies adopted by poultry farmers in response to climate change impacts is crucial for informing policy, research, and extension efforts aimed at enhancing the resilience of poultry production systems. The result also revealed that majority 45.2% of the respondents believed on the strategy

Effect of Climate Change on Poultry Production in Maiduguri Metropolis, Borno State, Nigeria

adapted to be very effective. The findings shows that understanding farmers' perceptions of the effectiveness of mitigation strategies is crucial for informing policy, research, and extension efforts aimed at enhancing the resilience of poultry production systems. Attaining the optimal range of climatic variables in the open-sided poultry houses common in the tropics is difficult and almost impossible (Abioja, 2010). However, proper ventilation is essential in minimizing the effect of heat in African poultry housing units. Furthermore, the study showed that majority of the respondents 75.0% received training or support related to climate change on poultry farming, while 23.8% do not receive training or support related to climate resilient poultry farming in the study area.

CONCLUSION

The study concludes that the poultry farmers in Maiduguri are married women that are in their economically active years. There are less experienced though poultry farming is their primary occupation and their major sources of income are the Non-Governmental Organizations in their locality. Ambient temperature, rain fall, disease and mortality are the factors that influence output of poultry. The mitigation strategies adopted in response to climate change impacts, were changing breeds, improving ventilation and cooling systems, adjusting feeding practices, and increasing access to clean water. Additionally, majority of respondents received training or support related to climate change on poultry farming from Non-Governmental Organizations (NGOs).

It is recommended that advanced training and education for poultry farmers with formal education is required since a substantial number of respondents have formal education, there's an opportunity to provide advanced training and education in poultry farming practices to further improve efficiency and sustainability.

Adoption of climate-resilient strategies by farmers should be encouraged so that they can adopt climate-resilient strategies such as changing to heat or cold-resistant breeds and improving ventilation and cooling systems to mitigate the impact of climate change on poultry farming.

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Effect of Climate Change on Poultry Production in Maiduguri Metropolis, Borno State, Nigeria

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