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Effects of climate change variables on poultry production system and the need for strategic climate actions in Delta State, Nigeria

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Abstract

Poultry production system plays an important economic, nutritional and socio-cultural role in the livelihood of households in Delta State, Nigeria. Our present knowledge of the effect of climate change variables on poultry sub sector is significantly inadequate, unclear and thus attracting empirical investigation in recent times. This study drives its significance from the current global and national debates on climate change and its impact on livestock production system, particularly among poultry production systems. This study investigates the effects of climate change variables on poultry production system in Delta State, Nigeria (2008 -2018). A ten year (2008-2018) time series data were collected on climate variables (temperature, humidity rainfall and sunshine duration) were elicited from NIMET website. Also 10 year time series data on poultry egg and broiler production were collected from FAOSTAT. Collected data were analysed with the relevant statistical tools (descriptive statistics and inferential statistics). The result shows that poultry meat output range from 26,000 to 273000 tonnes with a mean of 200,738.63 tonnes. Poultry egg output ranges between 489,288 tonnes to 660,000 with a mean of 591,327.45 tonnes. Multiple regression result shows that climate variable s explained 60.2% of the variation in poultry production. Test of hypothesis reveals that temperature and rainfall are the most significant climate variable ($P \leq 0.05$) that influenced poultry production. It was recommended that strategic climate change actions such as regulating poultry house temperature, should be practiced by poultry farmers in order to generate better output of eggs and broiler.

Keywords: Climate Change; Climate Variables; Poultry Egg; Broiler Production System; Strategic Actions; Nigeria

1. Introduction

The poultry industry is one of the most viable and popular agricultural business industries in Nigeria. Climate change poses negative impacts on animal productions, especially in relation to poultry (Adesiji et al., 2013). Globally, it is arguably the most important environmental issue of our time. It could affect animal production due to the impacts of increasing air temperature, feed-grain availability and favouring diseases proliferation (Adams et al., 1990).

In Sub-Saharan Africa, it has been predicted that climate change will exert negative impacts on the food security (Thompson et al., 2010). Globally, food production has significantly reduced drastically because of the negative impacts of climate change on agricultural produce (Parry and Rosenwieg, 1994). However, the regional impacts are likely to be substantial and variable where technologies transformed and favoured its effects in some areas while causing devastating effects in tropical environments. In the tropics, shortage of food production and security will be on the increase generally due to climate change while developed countries with improved technology and adaptive capacity will benefit.

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The environmental conditions affecting the performance and productivity of chicken have been identified to include temperature, relative humidity, light, sunshine prevailing at a given time, housing system and ventilation (Elijah and Adedapo, 2006). The performance and survivability of poultry produce largely depends on ambient temperatures.

Production of poultry meat of Nigeria increased from 45,600 tonnes in 1968 to 201,493 tonnes in 2017 growing at an average annual rate of 3.35% (tonnes) in 2017. While in 2017, production of eggs for Nigeria was 510,000 tonnes. In Nigeria, eggs production increased from 100,000 tonnes in 1968 to 510,000 tonnes in 2017 revealing an upward annual rate of 3.91%.

The problem of heat stress can be further compounded in a hot environment when the humidity rises. Several studies have opined the negative effects associated with heat stress on the general performance of poultry. There are two types of heat stress; acute heat stress which is associated with short period of exposure while chronic stress is the relatively longer period of exposure.

Housing patterns such as open-sided houses commonly used in tropical environment are prone to chronic stress. The negative effects of heat stress on the performance characteristics of birds have been consistently reported.

Climatic change poses the challenges of both loss of productivity and increase in production cost. At this stage, the uncertainly is whether poultry farmers are aware and knowledgeable of the threat posed by climatic change and its effects on poultry production systems. Gaining adequate knowledge on this subject matter will drive development in the poultry industry in Nigeria.

The poultry sector of the agricultural industry is considered a viable sector to boost the economy of Nigeria. However, the sector faces some constraints for future development mainly from the threat from climatic change. A study on climatic change impacts on poultry production system will serve as a useful tool in improving production and as a guide for robust policy making. It will also may avail local technologies that would reduce climatic change threats.

This study was designed to provide answers to questions, concerning climatic change and it's implication on poultry production systems in Delta State, Nigeria.

The specific objectives of the study were to :-

- Ascertain the mean poultry egg production in Nigeria. (2008- 2018).
- Examine the average broiler production in Nigeria (2008-2018).
- Examine the trend of variation of climate variables
- Evaluate the impact of climate variables on poultry egg production in Nigeria (2008-2018).
- Determine the impact of climate variables on broiler production in Nigeria (2008 -2018).

The following hypotheses were formulated and tested for the study:

- **Ho_1:** There is no significant relationship between climate change variables and broiler production.
- **Ho_2:**There is no significant relationship between climate change variables and poultry egg production.

2. Materials and Methods

2.1. Study area and data collection techniques

The Federal Republic of Nigeria, is a tropical country, located in West Africa, bordering Niger in the north, Chad in the northeast, Cameroon in the east, and Benin in the west. Its coast in the south is located on the Gulf of Guinea in the Atlantic Ocean. For the purpose of this study, data (time series) data for climate variables for poultry output including the time range 2008-2017 was collected through secondary data sources. The derivations of prior research works and mediums such as journals, textbooks and research reports and others as applied by the researcher in a bid to carry out this research work constitute the data for this study.

2.2. Method of data analysis

The data collected for this study were analyzed using descriptive and inferential statistical tools such as frequency distribution table, percentage, mean and multiple regression. Inferential statistics were used to test the hypothesis. Multiple regression statistical tool were used as stated in the objectives.

- **Objective I;** was achieved using inferential statistical tools such as graph, percentage, mean and standard deviation.
- **Objective II;** was achieved using descriptive statistics such as Mean, standard deviation and graph
- **Objective III;** (the impact of climate variable on poultry egg in production Nigeria)wasachieved using multiple regression.
- **Objective IV;** (determine the impact of climate variable on broiler production in Nigeria) was achieved using multiple regression.

The correlation analysis was used to determine the nature of relationship between the independent variable (Temperature, Relative humidity, Rainfall, Sunshine duration) and dependent variable (Poultry production). The dependent variables are poultry broiler production and poultry egg production, while the independent variables are Temperature (TEM), Relative humidity (RH), Rainfall (Rf), Sunshine duration (SD).

2.3. Model Specification

The implicit form of the model is specified thus:

PpFl = f (TEM, RH, Rf, SD)…….. (1)

Thus the generic model is given as;

$Y = \beta_0 + B_1(TEM) + B_2(RH) + B_3(Rf) + B_4(SD) + ei$ ---------- eq (2)

Where:

PpFl = Poultry production & Farmers Livelihood
a = The constant
TEM = Temperature
RH = Relative humidity
Rf = Rainfall
SD = Sunshine duration
$\mathbf{B_1} - \boldsymbol{\beta_4}$ = Parameter estimates.
$\boldsymbol{\beta_0}$ =Intercept
e = error term

3. Results and Discussion

3.1. Data Presentation

The study focused on the effect of climate change on poultry production in Nigeria. Three climate change variables (Temperature, Rainfall and Precipitation) and poultry production and value of egg production were sourced for the period 2008-2018. The data is presented in Table 1.

Table 1: Climate variables and poultry production in Nigeria (2008 -2018)

Year	Precipitation	Temperature	Rainfall	Poultry production	Egg production
2008	36.35	26.19	189.45	26000	581000
2009	45.57	28.86	224.98	273000	612600
2010	49.08	30.18	133.62	245000	609057
2011	47.96	29.5	157.55	198303	636000
2012	43.57	29.79	131.7	229129	640000
2013	54.34	30.07	136.1	193153	650000
2014	47.19	30.16	203.54	196583	660000
2015	49.62	30.17	153.72	204674	489288

2016	61.9	29.98	208.72	209149	504657
2017	46.3	29.48	178.79	201493	510000
2018	54.65	31.6	190.78	231641	612000

(Sources: Time series Data 2008 – 2018)

Table 2 Descriptive statistics of Climate variables and Egg productionin Nigeria 2008-2018

Descriptive Statistics						
	N	Minimum	Maximum	Mean	Std. Deviation	Coeff.of var.(%)
Precipitation	11	36.35	61.90	48.7755	6.63027	13.59
Temperature	11	26.19	31.60	29.6345	1.32526	4.47
Rainfall	11	131.70	224.98	173.5409	32.79645	18.90
Egg Production	11	489288.00	660000.00	591327.4545	61936.96824	10.47
Valid N (listwise)	11					

3.2. Mean Egg Production in Nigeria 2008-2018

The value of egg production in Nigeria ranges from 489288.00 tonne to 660000.00 Tonne with a mean value of 591327.45 Tonne and there is a strong relationship between this value of egg production and ever constant climate change in Nigeria.

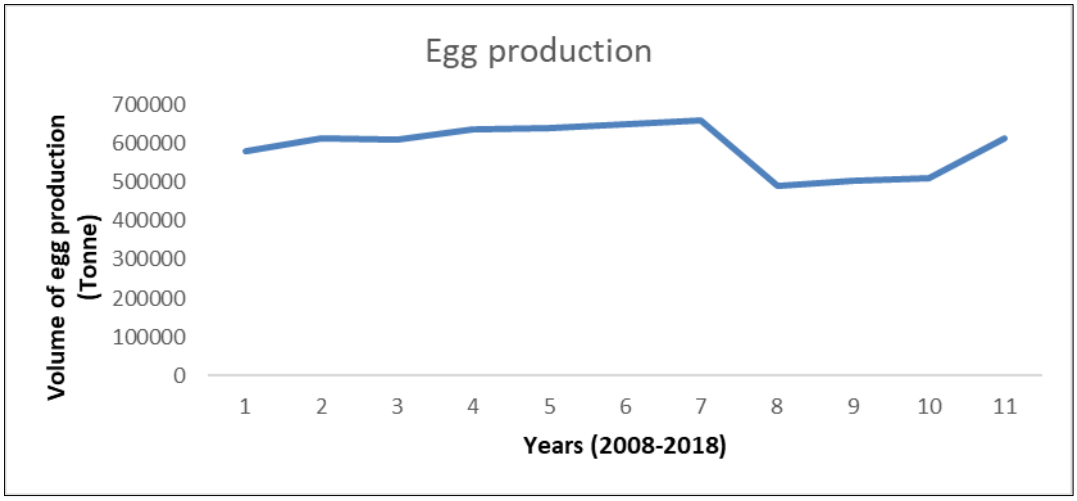

Figure 1 Line graph showing value of egg production in Nigeria 2008-2018

3.3. Variation in Annual Temperature (2008-2018)

Annual temperature in Nigeria ranges from 26.19 0^c to 31.60 0^c with an average annual temperature of 29.63. Temperature in Nigeria has been very erratic over the year as it respond to the ever changing climate as shown in fig 2.

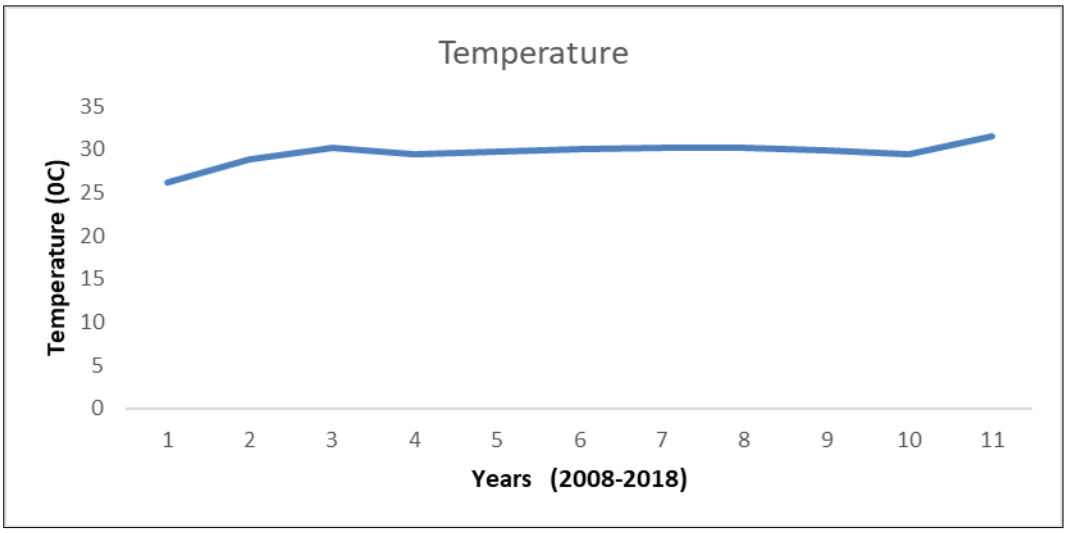

Figure 2 Line Graph showing Temperature variation in Nigeria 2008-2018

3.4. Annual variation in Rainfall in Nigeria (2008-2018)

Annual rainfall variation with coefficient of variation of 18.90% is one of the most unsteady and important climate variable . It ranges from 131.70 mm to 224.98mm. It has great impact on poultry production activities. The mean annual rainfall in Nigeria from 2008-2018 is 173.54 mm which is a high deviation from the mean as shown in fig 3.

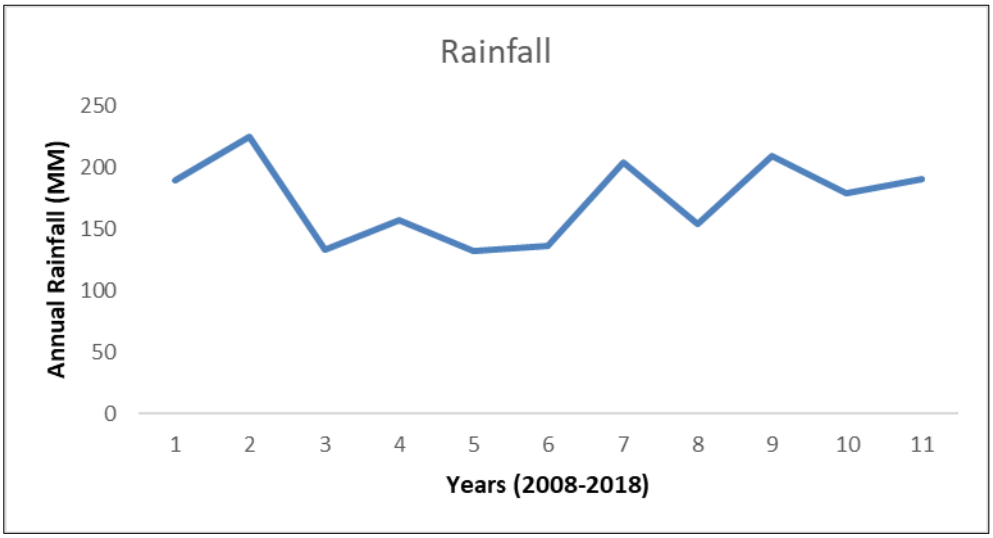

Figure 3 Line Graph Showing the trend of Rainfall Variation in Nigeria 2008-2018

3.5. Poultry Production in Nigeria

Value of poultry production in Nigeria ranges from 26000.00 tonne to 273000 tonnes with a mean value of 200738.63 tonnes. There is a strong relationship between this value of poultry production and ever constant climate change in Nigeria.

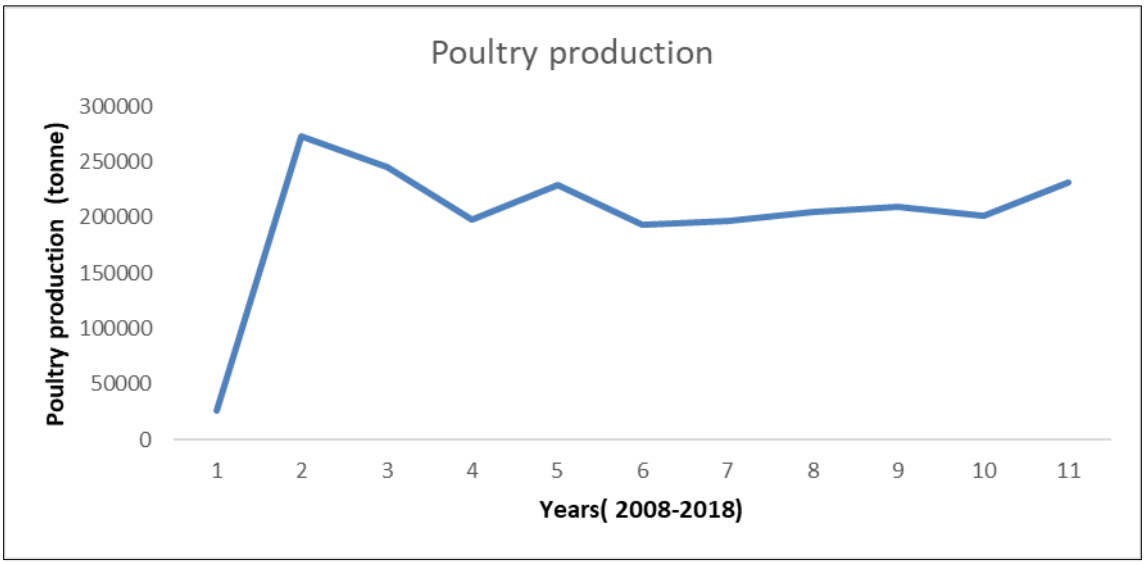

Figure 4 Line graph showing value of poultry production in Nigeria 2008-2018

3.5.1. Annual Mean of Precipitation in Nigeria (2008-2018)

Annual precipitation in Nigeria ranges from 36.35 inches to 61.90 inches with mean value of 48.77 inches which has never been consistent throughout the period (2008-2018) due to rapid changing climate as shown in figure 5.

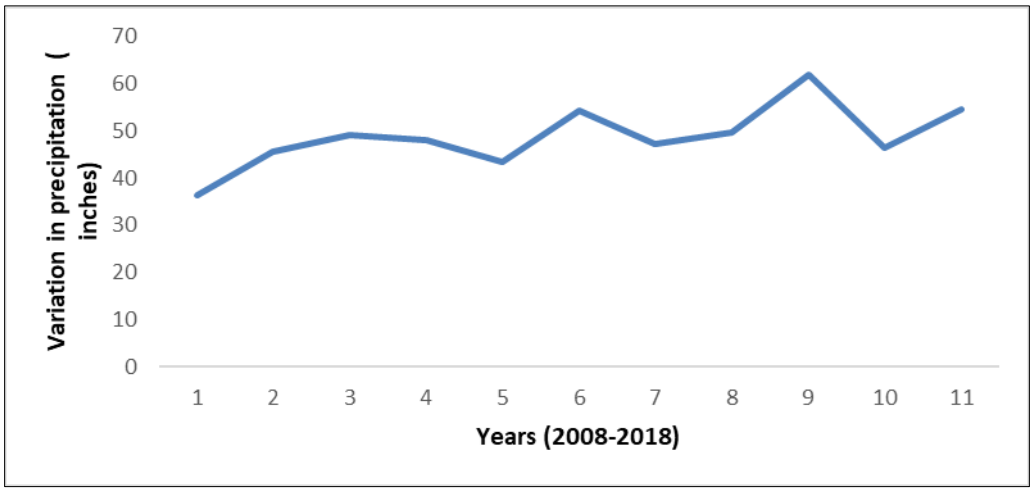

Figure 5 Line graph showing Precipitation variation in Nigeria 2008-2018

3.6. Result of econometric model

3.6.1. Effect of climate change variables on poultry production 2008-2018

The data was subjected to statistical analysis to establish the effect of climate change on poultry production in Nigeria and the result presented .

Table 3 Model Summary

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	0.776[a]	0.602	0.432	47464.80585
a. Predictors: (Constant), Rainfall, Precipitation, Temperature				

Table 4 ANOVA[a]

ANOVA[a]						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	23872512175.294	3	7957504058.431	3.532	0.047[b]
	Residual	15770354559.251	7	2252907794.179		
	Total	39642866734.545	10			
a. Dependent Variable: Poultry Production; b. Predictors: (Constant), Rainfall, Precipition, Temperature						

Table 5 Result of linear regression between climate variable and poultry production in Nigeria

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	-1050639.714	442052.417		-2.377	0.049
	Precipition	-1615.612	3420.508	-0.170	-0.472	0.651
	Temperature	43304.428	17430.748	0.911	2.484	0.042
	Rainfall	270.101	110.820	0.141	2.437	0.038
a. Dependent Variable: Poultry Production						

From the result of linear regression between climate variable and poultry production in Nigeria revealed significant relationship between poultry production and climate change P<0.05 (95% confidence interval)

The coefficient of determination R^2 0.602 (60.2%)and adjusted $R^2$is 0.432 as shown in model summary Table 3. This implies the independent variable (climate change) was able to explain variation the poultry production(dependent variable) in Nigeria. From the result 60.2% change in poultry production is accounted by change in climate variable (ie climate change) this result is robust and consistent with apriori expectation as Durbin Watson statistics (DW 1.778) show absence of serial correlation among the variable.

The coefficient values show that temperature and rainfall are the significant climate change variable that affects poultry production in Nigeria. Temperature P0.042 <0.05(t 2.484) show positive correlation between temperature in poultry production. Rainfall P 0.038 <0.05 (t 2.437) has a significant and positive relationship with poultry production in Nigeria. Precipitation p 0.651 >0.05 (t -0.0472) has no significant effect on poultry production in Nigeria.

Table 6 Effect of Climate Change on Egg Production 2008-2018

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	0.706[a]	0.665	0.653	67656.43921
a. Predictors: (Constant), Rainfall, Perception, Temperature				

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6320123986.614	3	2106707995.538	6.550	0.019[b]
	Residual	32041756364.113	7	4577393766.302		
	Total	38361880350.727	10			
a. Dependent Variable: Egg Production						
b. Predictors: (Constant), Rainfall, Perception, Temperature						

Coefficients[a]						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**T**	**Sig.**
		B	Std. Error	Beta		
1	(Constant)	232552.161	630102.493		0.369	0.723
	Perception	-5070.078	4875.599	-0.543	-1.040	0.333
	Temperature	21133.876	24845.827	0.452	0.851	0.023
	Rainfall	-116.527	698.190	-0.062	-0.167	0.002
a. Dependent Variable: Egg Production						

The result of the analysis of climatic variables and egg shows that R^2 which is the coefficient of determination for the collective effect of all of the independent variables (Temperature, rainfall, and precipitation) is 0.665. This implies that about 66.5% of the variance of the dependent variable (egg production) was explained by the independent variables. In other word, only 33.5% (i.e. 100-66.5) of egg production is not explained by the independent variables.

Also, the F- Ratio value of 6.53 shows that a significant relationship existed between egg production and the selected climatic elements at 5% level. This result is in agreement with Achoja and Emaziye (2015) and Achoja (2013) who earlier reported a significant relationship between climate variables and aggregate agricultural output (AOP) and Gross Domestic Products (GDP) in Nigeria.

3.7. Strategic actions on climate change

3.7.1. Government intervention programs

Government actions include agricultural subsidy and support programs, and resource management programs in relation to climate variability. Funds are made available to poultry farmers to reduce the risk of income loss due to floods, droughts and other consequences of climate change. Funds are generated through national disaster compensation and income stabilization .Farm financial strategies

Farm financial adaptation involves developing farm income strategies to minimise income loss associated with climate change. Incentive programs and government support provide significant assistance for farm financial management. This adaptation consists of income stabilisation programs, crop shares and futures, crop insurance, and diversified household off-farm income. Income stabilisation programs assist farmers to minimise their vulnerability to climate variability

3.7.2. Farm production actions

Farm production adaptation activities consist of innovation of resources management, modification of farm operations, and timing of operations. Innovations of resource management address climate-related risks. For example, potential surpluses and deficiencies of moisture due to either frequent droughts or floods or changes in rainfall patterns can be addressed by water resource management innovations. Modifying farm production practices may also include the diversification of enterprises (Achoja and Okpara, 2016),.

3.8. Technological developments

Technological developments include crop development and efficient climate information systems. Crop development usually involves production of new crop varieties that possess better suitability and tolerance to heat, drought, and climate variability; An efficient climate information system for farmers to minimise the negative impact of climatic variability would likely include daily and weekly weather forecasts. These would inform timing of planting and harvesting activities. Additionally, seasonal predictions would provide assistance for risk assessment and decision making over a number of months Longer-term climate change information would assist farmers to visualise future climate norms and variability of extreme events. Farmers would apply climate information for making decisions to adapt to climate change

4. Conclusion

In Nigeria, temperature and rainfall have significant effect on egg and meat poultry production. Precipitation and rainfall have the highest rate of variation and thus exerted more influence on poultry production system in Nigeria over the period under review. The dissemination of innovations by Extensionist and other agencies on the negative impact it has on poultry production and the need for collective strategic adaptive actions. Farmer can reduce effect of climate change through proper ventilation of poultry houses, planting of tress and use of heat resistance birds for poultry production.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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