Determinants of Factors Influencing the level of Mitigation of Heat Stress on Broiler in Oyo State

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KEYWORDS

Broiler
Determinants,
Mitigation level,
Perceived heat stress,

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ABSTRACT

Compared to developed nations, Nigeria has a gap in its protein consumption. Poultry production being seen as a way out of this problem is faced with climate change challenges. Smallholder broiler farmers were the most vulnerable due to low copping infrastructural capacity. This study, therefore, investigated the determinants of factors influencing the level of mitigation of heat stress (HS) on broiler by farmers in Oyo state. The study employed a systematic sampling technique using registered members of the Poultry Association of Nigeria. Structured questionnaire was used to collect data: demographic, socioeconomic profile, institutional factors, perceived heat stress and coping methods. Data were analyzed using descriptive statistics and multinomial logit regression α=0.05. The study revealed that majority (76.7%) were male, mean age=48years. The average years of education and rearing experience were 12 and 6 years respectively. Majority (71.67%) accessed extension/vet doctor services, while only (23.3%) accessed credit. Temperature was perceived to be highest in January-March, while extremely cold weather was perceived in August. The symptoms of HS identified were gasping, wing raising, docility, reduction in feed, increased water intake, panting, weight loss, slow growth rate, pest and disease infestation, vaccine failure and increase mortality. Multinomial logit result showed all the independent variables to positively influence the level of farmers' mitigation except sex and household size. Age, sex, access to credit and farmers' income, household size, education, rearing experience, labour used and stock size were significant at 1% and 5%. Access to credit and training were recommended

INTRODUCTION

The current global population is 7.6 billion. With about 83 million people being added to the world's population yearly, it is expected to be 8.5 billion by 2030, 9.7 billion in 2050 and 10.4 billion in 2100, (United Nations Department of Economic and Social Affairs, Population Division, 2022). It implies that seventy percent increase in food production is required between now and 2050 for food production to keep pace with the growing world population (Watt Executive Guide, 2012;2016). Presently, Nigeria has a gap in its protein consumption in comparison with other global economies (Nigerian Protein Deficiency Report, 2020 as cited in Daily Trust, 2021). By the year 2050 this problem would have escalated if adequate measures are not put in place. Poultry production is seen as the way out of this problem. Poultry contributed about 30% of animal proteins consumed globally (AGRA, 2014). Global poultry population is estimated to be about 16.2 billion, out of this 71.6% were in developing countries, producing 67, 718,544 metric tons of chicken meat and 57,861,747 metric tons of hen eggs (Hundie, *et al*.,2019). The poultry industry contributes significantly to the Nigeria's economy. It provides employment opportunities, income for the populace and serves as a source of high quality protein. It equally contributes to food security and poverty alleviation (Nasiru *et al.,* 2012).

Despite, the contribution of poultry to food security, poverty alleviation and economic growth, the industry is cumbered with numerous constraints which include climate among others. (Adeyonu, *et al*.,, 2021). Climate change has affected poultry production by imposing stress on the homeostasis in the birds due to extreme climatic situations: high temperature, flood or drought, and water scarcity (Tiruneh and Tegene, 2018). These conditions result in production losses (reduction in growth rate, decrease in number of egg a hen lay, increased morbidity and mortality (Henry, *et al*. 2012; Irivboje, *et al*., 2021*)*. Poultry birds has adaptive capacity to temperature increase, but the coping mechanisms subject the birds to losses and diversion of nutrients for production to thermoregulation (Irivboje, *et al*., 2021*)*. During, hot weather, feed consumption is reduced so as to reduce metabolic heat production.

Systemic nutrients are utilized for heat loss mechanisms instead of using it profitably for muscle accretion. Digesta mobility in the gastrointestinal tract is greatly reduced and efficiency of nutrient utilization in the intestines is lowered. Histomorphometric assessment revealed that the epithelial cells of the intestines are affected by heat stress (Shittu, *et al*., 2020). Vasodilation of blood vessels at the periphery reduces blood flow across gastrointestinal tract to lower the efficiency of digestion and nutrient utilization which in turn lowered the final live weight and dressing percentage (Okonkwo, and Ahaotu, 2019).

Broiler chickens, as a result of global warming grow so rapidly that muscular development surpasses bone development leading to metabolic bone disorder (Shields and Orme-Evans, 2015). The consequence of this is Sudden Death Syndrome manifesting by sudden convulsions and wing-beating, and birds lie on their backs (Julian, 2005). ICAR (2010) Network Project on Climate Change noted that, as environmental temperature ≥ 34°C is reached broilers mortality due to heat stress increases by (8.4%) as compared to layers (0.84%). The burden of heat stress commonly experienced in the tropical areas of Africa will be aggravated by climate change going by the predicted global temperature surge of between 3^{oC} and 6° C (ICAR- Directorate of Poultry Research, 2020). Rainfall and wind that give relief to heat stressed birds are now scarcely experienced.

Under this scenario, the feeding strategy, housing and other management practices being used presently have to be modified for farmers to be less vulnerable to this adverse conditions. The selection strategy for both layer and broilers has to be reoriented to come up with heat tolerant varieties. Genes responsible for conferring better adaptability may be introgressed into the high performing low adaptive varieties through traditional as well as molecular breeding tools (ICAR- Directorate of Poultry Research, 2020)

Adaptations are adjustment to interventions or shock, which is done to manage the losses or take advantage of the opportunities that is presented by a changing climate (IPCC, 2013).

The main goal of mitigation is to increase the capacity of the system to survive external shocks/changes. With the foregoing, the study therefore, has these specific objectives:

(i) profile the perception of farmer to temperate change; and (ii) determine the factors that influence the level of mitigation against heat stress.

METHODOLOGY

Types and Sources of Data

This study was carried out in Oyo States, Nigeria. The study employed primary data. The data collected include the demographic: gender, age, marital status, level of education, household size, rearing experience, primary occupation and socioeconomic profile: access to credit, income, access to extension, rearing system, stock size, mortality rate of the respondents, perceived heat stress data and coping methods adopted. Institutional factors include access to extension services, access to credit

Sampling Techniques and Sample size

Oyo States was the purposive selection out of the six states in southwest Nigeria; based on the highest poultry population distribution in the state, (Federal Department of Livestock, 2010). The study employed a systematic sampling technique based on available records of registered members of the Poultry Association of Nigeria (PAN). The systematic sampling technique enables the probability that any member of the Poultry Association of Nigeria to be selected. This sampling method is an equal probability selection method. It is used to easily identify suitable sampling frame (CASRO, 2011). It has the disadvantages of difficulties in determining the precision of estimates and for large data sets it tend to be time consuming to process. Systemic sampling technique is a non-random sampling technique in which the first member of the sample is pre-selected by random sampling method. Thereafter selection is as kth item on the list where k is a positive integer such that k =$\frac{N}{n}$where N= total population and n= total number of sample size.. A well-structured questionnaire was used to elicit data from the broiler farmers. The total number of respondent broiler farmers selected were 120

Analytical Framework

Descriptive Statistics

Demographic, socioeconomics characteristics and perceived effects of climate change and adaptation strategies, were captured using, percentages, mean, graphs and frequency Climate Change Adaptive Index

Climate Change Adaptive Level Index for the broiler farmers was constructed so as to classify the farmers into different classes of adaptation levels. This was based on the number of actionable mitigation steps against the climate changes factors that take yes=1 and no=0 answers in the questionnaire. The maximum number of actionable steps allowed to state in the questionnaire were eight: planting trees around the poultry houses, installation of mist blowers, reformulate the diet, giving of chilled water to birds, reduce stock density per meter square, provide enough ventilation, repeat vaccination, improved droppings management. A farmer who did not take any action get score of zero, if 1 action was taken the farmer get a score of 1, 2 actions get a score of 2 up to score of 8. Composite score

was then used to classify farmers to different adaptive level: high, intermediate and low; the categorization is done based on, High level: Between 5 points to mean standard plus deviation, Intermediate level: Between upper and lower categories, Low level: Between mean minus standard deviation point to zero

Multinomial Regression

Logistic regression can be extended to handle polytomous responses when the dependent variables (Yi) is taking i >2 categories this is refer to as multinomial regression.

, El-Habil (2012). Multinomial logistic regression applies maximum likelihood estimation in transforming the dependent variable into a logit variable, while changes are calculated in the log odds of the dependent and not in the dependent itself as in the ordinary least square. The multinomial logistic regression adopted from EL-Habil (2012) is defined as:

$$Log\left[\frac{\pi_j(X_i)}{\pi_i(X_i)}\right] = \alpha_{oi} + \beta_{1j}X_{1i} + \beta_{2j}X_{2i} + \cdots \beta_{pj}X_{pi} \quad (1)$$

Where $j = 1, 2, \ldots (k-1)$, i = 1, 2, …, n

Where all the π*'s* adds to unity, then the reduced model is:

$$Log(\pi_j(X_i) = \frac{exp^{\alpha_{oi}+\beta_{1j}X_{1i}+\beta_{2j}X_{2i}+\cdots\beta_{pj}X_{pi}}}{\sum_{j=1}^{k-1} exp^{\alpha_{oi}+\beta_{1j}X_{1i}+\beta_{2j}X_{2i}+\cdots\beta_{pj}X_{pi}}} \quad (2)$$

Where π is the response categories or level of mitigation strategies adopted by broiler farmers, Xi are the vector(s) of explanatory variables (demographic: gender, age, marital status, level of education, household, size, rearing experience and socioeconomic characteristics: access to credit, access to extension, stock size, mortality rate), βj is the parameter to be estimated which uses maximum likelihood, estimate method (Chatterjee and Hadi, 2006).

Multinomial logistic regression uses a baseline category and the predicted probability of estimate is defined as:

$$\pi_j = \frac{e^{\alpha_j+\beta_j Y}}{\sum_h e^{\alpha_h+\beta_h Y}} \quad (3)$$

The first or last endogenous products are often used as the baseline sample, the probability of each socioeconomics and demographic characteristics is predicted from:

$$\widehat{\pi_1} = \frac{exp(y_i)}{1+\sum exp(y_i)} \quad (4)$$

Where y_i is the predicted responses from the multinomial coefficient. The multinomial logistic regression model is simply defined as:

$$Log(\pi_i(X_i)) = \alpha_{oi} + \alpha_{1j}X_{1i} + \alpha_{2j}X_{2i} + \cdots \alpha_{pj}X_{pi}$$

Where: π is the response categories or level of mitigation strategies adopted by broiler farmers

α_i = parameter to be estimated

X_i = vectors of socioeconomics and demographic characteristics.).

The explanatory variables are as follows: X_1 = Age of broiler farmer (years), X_2 = Sex of broiler farmer (dummy variable, 1 = male; 0 =female), X_3 = Household size, X_4 = Marital status of broiler farmer (married = 1; single, divorced or widowed = 0), X_5 = Educational level of household of broiler farmer in years , X_6 = Extension Access to credit 1if Yes; 0 otherwise , X_7 = Experience, X_8 = labour for broiler production, X_9 = stock size, X_{10} =Access to credit (dummy variable, 1 = access; otherwise =0), X_{11} = Income

RESULTS AND DISCUSSION

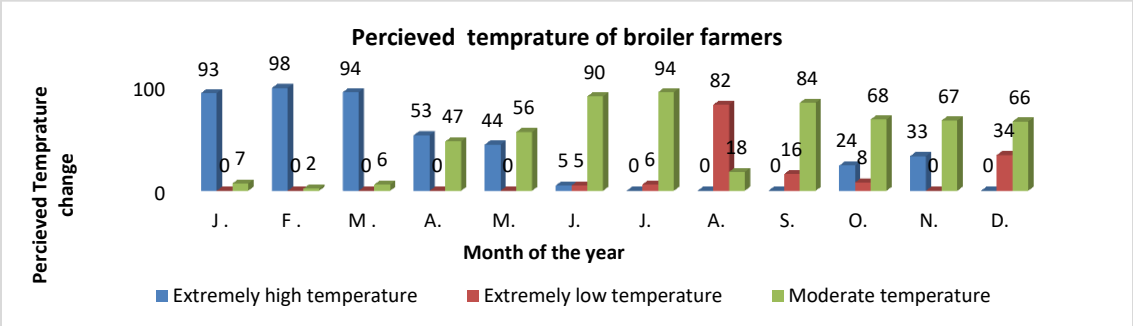

Fig. 1: Monthly perceived temperature changes of broiler farmers
Author's computation, 2023

Table 3: Determinants of factors influencing the level of mitigation against heat stress

Variables	**coefficient**	**P>Z**
Age	0.036	0.000
Sex	-0.382	-0.000
Household size	-0.041	-0.002
Marital status	2.008	0.215
Education	0.055	0.005
Extension	0.03	0.011
Experience	0.010	0.004
labour	0.800	0.002
Scale	1.91	0.008
Access to credit	7.74e08	0.000
Income	9.11e08	0.000
cons	11.98	
observations	120	
LRChi^2	164.82	
Prob b>Chi	0.0000	
R^2	0.53473	
Log likelihood	-160.9062	

Author's computation, 2023

Determinants of factors influencing the level of mitigation against heat stress

The level of farmers' adoption of mitigation strategies was estimated using multinomial logit model(MNL). MNL was estimated by normalizing one category referred to as the base category. The parameter estimates provided only the direction of the effect the independent variables in the dependent variables and do not represent the actual magnitude of change of probabilities. Thus, the marginal effects of the MNL, which measure the expected change of a particular level with respect to a unit change in an independent variable, are reported and explained. The table presents the marginal effects along with the level of significance. The MNL diagnostic statistics revealed the log likelihood as -160.9062 with p value of 0.0000. pseudo R^2 of 0.535 and log likelihood Chi^2 164.82. This implies that the model as a whole significantly and jointly predicted the level of mitigation of broiler farmers against heat stress in the study area.

The results on the table show all the independent variables to positively influence the level of farmers' mitigation against heat stress except sex and household size. Age, sex, access to credit and farmers' income were significant at 1% level of significance, while, household size, education, rearing experience, labour used and stock size were significant at 5% level of significant.

CONCLUSION

In conclusion heat stress is a serious issue in the study area. It is perceived to be sever in the month of January to march, but began to subside from the month of April. The short term symptoms of heat stress in broiler were identified to be gasping, wing raising, docile birds, reduction in feed intake, increase water intake and panting while, long term symptoms of heat stress in broiler were weight loss, slow growth rate, pest and disease infestation, vaccine failure, and increased mortality. Age, access

to credit and farmers' income, education, rearing experience, labour used and stock size were significant factors that positively influence the level of farmers' mitigation against heat stress.

RECOMMENDATIONS

Therefore, this study recommends:

i. Rearing experience and education improved the level of farmers' mitigation against heat stress., therefore, farmers should be trained periodically to increase their awareness to mitigation strategies and there be encouraged to improve the mitigation level to heat stress.

ii. Access to credit and farmers' income improved the level of farmers' mitigation against heat stress in broiler, therefore, government and stockholders in the business should make credit accessible to farmers and farmers are encouraged to join cooperative group to be able to access credit.

iii. labour used and stock size improved the level of farmers' mitigation against heat stress in broiler, therefore, factors that keeps the farmers operating at the smallholder level: adequate credit, small market share and electricity problem that discourage storage of products should be addressed.

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