Original Research Article

Analysis of backyard poultry farmers' awareness, perceptions, and adaptability to climate change in Tonkolili district, Sierra Leone

ABSTRACT

The poultry industry worldwide suffers significantly due to climate change, which may affect the chicken protein source. The study examined backyard poultry farmers' awareness, perceptions, and responses to climate change in Tonkolili, Sierra Leone. Data were collected from 232 backyard poultry farmers using a semi-structured questionnaire. The data were analyzed using SPSS 23.0 Software. According to the respondents' socioeconomic profiles, the majority of farmers (53.4%) were between the ages of 31 and 40 years, and most of them were female (59.5%) and married (54.3%). The average household size was between 5-8 persons, and the majority of respondents (59.5%) lacked formal education. The poultry farmers are well aware of climate change (96.6%), and that decrease in rainfall ($\bar{x}$ = 3.45) and increasing temperature ($\bar{x}$ = 3.39) affects poultry production, leading to high incidences of poultry diseases ($\bar{x}$ = 4.11), increases the cost of feed ($\bar{x}$ = 3.99), and reduces the quantity of egg production ($\bar{x}$ = 3.92). The logistic regression model results showed that the positive and significant factors that influenced climate change awareness are gender and sources of climate change information. Some of the adaptation strategies practices by the farmers are an adequate supply of drinking water, increased quantity of supplementary feed, and rearing a different variety of birds. Climate change affects backyard poultry production therefore, poultry farmers should be provided with technical training and assistance through extension services to help alleviate the impact of climate change on backyard poultry production.

Keywords: *Adaptative response, Climatic variables, Farmer's perception, Poultry production.*

1. INTRODUCTION

Backyard poultry production has been vital and valuable worldwide as it provides chicken meat and eggs, which are the most crucial protein source among animal food [1]. It is defined by a variety of factors, including the use of an indigenous night shelter and scavenging methods as well as natural chick hatching and low bird productivity [2]. Backyard poultry farming is prevalent in rural areas and consists primarily of unremarkable village chicken breeds. Depending on the language used in the area, these chickens are also known as 'rural', 'backyard', 'indigenous', 'scavenging', 'traditional', 'local', 'native', or 'family' chickens [3]. Backyard Poultry farming in rural areas promotes self-employment and offers protein-rich, relatively inexpensive food as supplemental income [4]. When compared to other industries, poultry farming plays a leading role in the livestock sector in certain regions of the world [5, 6]. This is due to the fact that the demand for animal products, most notably chicken, is growing as a result of the rise in the world's population and the spread of urbanization [7].

The growth of the poultry industry across the world suffers significantly due to climate change, which may affect the chicken protein source [8]. Nyoni et al. [9] indicate that a changing climate may compound or directly influence existing backyard poultry production challenges, such as slow growth rates and reduced egg production. Excessive temperatures, especially when mixed with excessive humidity, cause great stress to birds and decrease their performance [10, 11]. Heat stress hurts the physiological, immunological, and gastrointestinal health of poultry birds, which ultimately leads to large economic losses in the poultry industry. This is because chicken genotypes have limited tolerance for high temperatures [1]. Heat stress on the birds affects egg production, quality, size, and weight loss, negatively influencing meat output in backyard poultry farming [12].

In Sierra Leone, 90 percent of poultry production is done in rural areas, and most of the households (59%) in the country keep at least one chicken [13]. Poultry is the most considerable livestock among the other livestock specie rear in the country, and it is overwhelmingly female-owned and operated with a traditional management system [14]. The farmers' conventional management system characterizes backyard poultry production with high mortality, poor breed selection, inadequate biosecurity, diseases, predators, and insufficient feeding and housing [15]. However, this made the domestic chicken production not fulfill 100% of the country's demand for chicken meat and eggs [16]. Sierra Leone consumes over 200 million eggs per year, but domestic production only meets 20% of the need; imports meet the remainder [17].

Global Climate change poses a significant threat to agricultural and animal production in developing nations since they are climate-dependent; thus, it requires a thorough understanding by the farmers [18]. It is of the utmost importance to analyze the effects of climate change-induced circumstances on the poultry industry and the adaptation measures used to mitigate these effects. As a result, a better knowledge of farmers' adaptability might facilitate the prioritization of adaptation response strategies and initiatives [19]. However, there is no research on poultry farmers' awareness and views of climate change in the study region. Hence, this study aims to assess backyard poultry farmers' awareness and perception of climate change in rural areas of Tonkolili District, Northern Sierra Leone.

2. METHODOLOGY

2.1 Study area

The study was done in Sierra Leone's northern area, in the Tonkolili district. It is centrally positioned in the nation, sharing boundaries with seven of its fifteen districts. It is divided into two relief belts: highlands and lowlands. Climate-wise, the district is typical of the rest of the country. It's characterized by a humid semi-equatorial climate with two diverse seasons. The rainy season runs from May to October, while the dry season runs from November to April. Agriculture, mining, and business are the district's primary livelihood alternatives, representing the district's socioeconomic characteristics. Tonkolili district has the most significant number of poultry populations in the country, even though household farmers commonly practice rearing animals like sheep and goats.

2.2 Sampling procedure

The data was collected in eight villages in the yoni chiefdom of the Tonkolili district such as Yonibana, Masorie, Makorie, Mile 88, Rochen, Gaindema, Matatie and Kontha. The survey was directed at backyard poultry producers in the eight communities. The data was gathered via a semi-structured questionnaire. The questionnaire was pre-tested on 6th August 2021 in three villages (Matatie, Kontha, and Makorie) within the targeted chiefdom. A simple random sampling was used with the help of the different villages' heads and chiefs in the respective study areas. Subsequently, 232 farmers were selected and interviewed face to face starting on 2nd October 2021 to 20th November 2021.

2.3 Data analysis

The socioeconomic characteristics of poultry farmers' management practices and adaptation strategies were determined using frequency count and percentages. Logistic regression was conducted to identify the vital factors determining farmers' awareness of climate change. A four-point Likert-type scale: Very Severe = 4, Severe = 3, Moderately severe = 2, and not severe = 1, was used to determine the perceptions of the poultry farmers on the effect of climatic variables on household poultry production was analyzed and described. A mean score greater or equal to 2.5 was considered critical in the study. The degree of perceptions of climate change impacts backyard poultry production was also analyzed and defined using mean score values on a five-point Likert scale: Strongly agree = 5, agree = 4, Neither agree nor disagree = 3, Disagree = 2, and strongly disagree = 1. Perceived effects on chicken production with a mean score more than or equal to 3.0 were likewise judged substantial. Cluster analysis was used to build clusters based on poultry farmers' replies to all matters included in their perceptions of the consequences of climate change on their production activities. The Statistical Package for Social Scientists (SPSS) version 23.0 was used to analyze the data. The data was presented in tables and charts regarding frequencies and percentages.

2.4 Logistic Regression Model

A binary logistic regression model was applied to quantify the factors impacting poultry producers' awareness and perceptions of climate change. This approach determines the likelihood of a yes or no response [20]. The binary dependent variable was assigned the value Y = 1 for chicken producers aware of climate change and Y = 0 for those who are not. The logit model was used in this investigation and is defined as follows: $Y = b_0 + b_1 X_1 + b_2 X_2 + b_3 X_3 {}^{\cdots} + b_{10} X_{10}$ - - - (1)

The following variables serve as explanatory factors: X_1 = Gender, X_2 = Age of poultry farmers (years), X_3 = Educational level of poultry farmers (years of formal schooling), X_4 = Marital status, X_5= Household size of poultry farmers (number), X_6= Climate change information, X_7= Economic activities, X_8 = Years of experience in poultry production (years), $b_1 – b_{10}$ = coefficients of variables, b_0 = intercept, u= error term.

3. RESULTS AND DISCUSSION

3.1 Socioeconomic characteristics of backyard poultry farmers

According to Table 1, most farmers (59.5%) in the research region were female, whereas (40.5%) were male. This indicates that both males and females are active in birdkeeping, albeit the female population is more prominent. The age distribution of the farmers shows that (53.4%) are between the ages of 31 and 40, and the majority (54.3%) are married. The farmers (64.2%) have a 5-8 person household size. The findings are consistent with the Population and Housing Census [13] report that most household in Sierra Leone has 5-6 persons. The majority of the farmers (59.5%) have no formal education. Conteh and Sesay [14] reported a similar result in Moyamba district Sierra Leone where (63.1%) of the farmers do not have formal education. Based on years of poultry rearing, most farmers (56.5%) had between 11 and 16 years of experience. This demonstrates that most poultry farmers have years of experience raising chicken in the area and may have a solid understanding of the effect of climatic fluctuation on their backyard poultry production.

Table 1: Socioeconomic characteristics of backyard poultry farmers (n=232)

Variables	Parameter	Frequency	Percentages
Gender			
	Male	94	40.5
	Female	138	59.5
Age(years)			
	Below 21	10	4.3
	21-30	7	3.0
	31-40	124	53.4
	41-50	53	22.8
	Above50	38	16.5
Household size			
	Less than 5	14	6.0
	5-8	149	64.2
	9-12	46	19.8
	Above 13	23	9.9
Educational level			
	No formal education	138	59.5
	Primary school	33	14.2
	Secondary school	46	19.8
	Tertiary education	15	6.5
Marital Status			
	Single	26	11.2
	Married	126	54.3
	Divorce	18	7.7
	Widow	48	20.8
	Widower	14	6.0
Years of keeping poultry birds			
	Less than 5	11	4.7
	5-10	52	22.4
	11-16	131	56.5
	17-22	28	12.1
	Above 23	10	4.4
Number of birds kept			

	>51	69	29.7
	51-100	45	19.4
	101-150	26	11.2
	151-200	84	36.2
	>200	8	3.4

Source: Field survey, 2021

3.2 Production and management practices of the backyard poultry farmers

The production and management practices of poultry farms in the Table 2 show that most (52.6%) of poultry farmers relied heavily on small-scale mixed farming (including livestock and crops) for their livelihoods. Variables on the production system (86.2%) had a free-range or extensive production system, while (13.8%) had a semi-intensive production system. Chicken obtained their feed from scavenging and supplementation (62.1%). The findings are consistent with Minh [21], who indicates that rural birds are kept on free range and fed with resources such as kitchen waste and cassava leaf meal as supplements for scavenging chicken. Most rural populations have long been recognized to rear more unimproved indigenous chicken birds because of their incredible difficulty, forcing them to self-scavenge with little or no extra feed, health care, or shelter offered [4]. Disease control in backyard poultry production is vital, and farmers must take it very seriously [22]. Findings reveal that only a few farmers (17.2%) appeared to be vaccinating their flocks against NCD regularly, whereas the vast majority (82.8%) did not vaccinate their birds. Rural poultry farmers do not vaccinate their birds due to a lack of vaccines available, the exorbitant expense of a vial of vaccine to an individual farmer, and concerns about the vaccine's effectiveness [23].

Table 2: Production and management practices of backyard poultry farmers (n=232)

Variables	**Parameter**	**Frequency**	**Percentage**
Other economic activities			
	Mixed farming	122	52.6
	Trading	48	20.7
	Civil services worker	31	13.4
	NGO worker	7	3.0
	Private sector worker	24	10.3
Chick rearing method			

	Free-range	200	86.2
	Semi-Confined	32	13.8
Types of feed			
	Kitchen wastes and leftovers	55	23.7
	Self-mixed feed	18	7.7
	Concentrates	15	6.5
	Scavenging and Supplementary feeding	144	62.1
ND vaccination program			
	Present	40	17.2
	Absent	192	82.8

Source: field survey, 2021

3.3 Poultry farmer's awareness of climate change

The level of public awareness is critical in identifying the most successful climate change adaptation solutions [24]. The study shows that (96.6%) of the farmers were aware of climate change, whereas (3.4%) were not (Figure 1). The result is similar to Shukla et al. [25], who noted that 85% of backyard poultry farmers are aware of the impact of climate change. The findings are also consistent with Ajayi [26], who found that 86.1% of farmers in Nigeria's Niger Delta area were well aware of climate change.

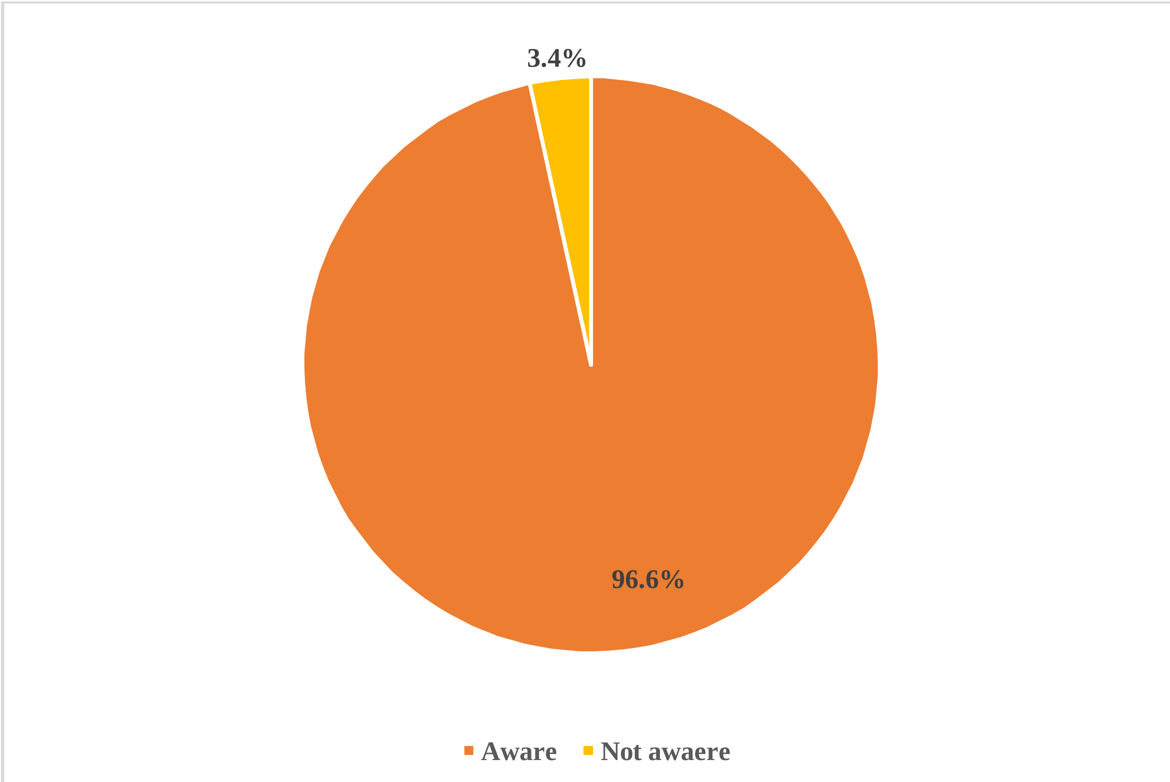

Figure 1: Poultry farmer's awareness of climate change

3.4 Poultry farmers' sources of climate change information

Climate change information is an essential factor in farmer awareness and understanding of climate change impact. The availability and accessibility of climate change information are considered significant drivers of farmers' awareness and understanding of climate change [27]. Backyard poultry farmers' sources of climate change information (Figure 2) reveal that the farmers received information about climate change mostly from their personal experience (43.5%). These findings contradict Ado et al. [28], who report that farmers in the aguire district in Niger obtained most of their knowledge regarding climate change via the local radio station (81.4%). The findings also contrast significantly with Umar [29], who found that farmers in Nigeria's Katsina State obtained information mostly from family and relatives.

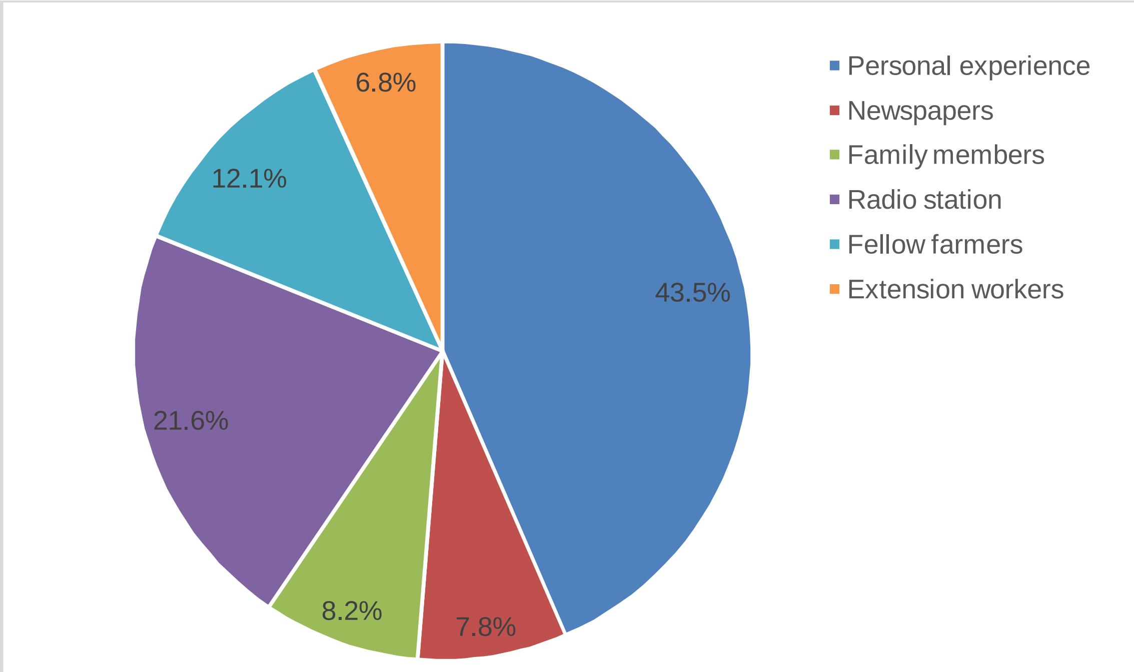

Fig. 2: Poultry farmer's sources of information about climate change

3.5 Factors determining farmers' awareness of climate change

Logistic regression was carried out to assess awareness of gender, age, educational level, marital status, household size, climate change information, other economic activities, and years of experience with climate change (Table 3). The overall model was considered fit to the data having a significant Chi-square 110.966, p < 0.023). The model explained 51.9.0% (Nagelkerke R2) of the Farmer's awareness level and correctly predicted 71.0% of the factors influencing awareness. These numbers imply a good match to the model. As a result, we can infer that all selected variables are well-fitting and accurately predict the factors impacting farmers' climate change awareness. Gender (p<0.004), age (p<0.043), household size (p<0.008), climate change source of information (p<0.043), economic activities (p<0.001) and farming experience (p<0.001), were significant but educational level (p=0.83) and marital status (p=0.80) were not.

According to the logistic regression test, gender and the availability of climate change information have a significant and favorable effect on poultry farmers' awareness of climate change. This shows that farmers who have access to information and knowledge on climate change are more probably to be aware of the impact of climate change. Ajayi [26] corroborates this, stating that mass media significantly influences growing awareness about climate change. Age has a significant negative coefficient, implying that a unit increase in the age of farmers diminishes their likelihood of being aware of climate change. This is consistent with Nhemachema and Hassan's [30] findings, which discovered a substantial negative association between age and awareness of climate change. Contradicts Adamu et al. [31] found a positive correlation between age and respondents' awareness of the impact of climate change. The findings indicated a negative association between the household size of poultry producers and their likelihood of being aware of climate change. This suggests that as family size increases, the likelihood of poultry producers being aware of climate change reduces. This contradicts Temesgen et al. [32] finding that a positive association exists between household size and climate change adaptation practices. The logistics regression equation was derived using a stepwise backward elimination of predictors technique. Non-significant predictors were omitted from the equation. The findings indicated that the anticipated logit of (awareness) = $6.43 + 1.33X_1 - 0.62X_2 - 0.97X_5 + 0.28X_6 - 0.71X_7 - 1.50X_8$.

Table 3: Factors determining farmers' awareness of climate change

Variables	**B**	**S.E.**	**Wald**	**Sig.**	**Exp(B)**
Gender X_1	1.341	0.469	8.180	0.004	3.824
Age X_2	-0.616	0.304	4.106	0.043	0.540
Education Level X_3	-0.049	0.233	0.044	0.834	0.952
Marital status X_4	0.042	0.169	0.061	0.804	1.043
Household size X_5	-0.973	0.369	6.944	0.008	0.378
Climate change source of information X_6	0.281	0.139	4.086	0.043	1.325
Economic Activities X_7	-0.705	0.174	16.429	0.000	0.494
Farming Experience X_8	-1.497	0.313	22.822	0.000	0.224
Model fittest					

Model test	Chi-square	Sig.	-2 Log-Likelihood	Percentage correct
Test for overall model	110.966	0.000	194.959	79.7
Hosmer and Lemeshow Test	16.253	0.023		
Pseudo R^2	0.52			

Source: Authors computation, 2021

3.6 Perception of the impact of climatic variables on backyard poultry production

Results from Table 4 reveal that the respondents perceived rainfall ($\bar{x}$ = 3.45), temperature ($\bar{x}$ = 3.39), relative humidity ($\bar{x}$ = 3.15), and sunshine ($\bar{x}$ = 2.58) as having a critical impact on backyard poultry production in the area. The findings align with Onubuogu and Esiobu [33], who stated that household poultry is constrained by temperature, sunshine, relative humidity, and rainfall in Nigeria. This study also agrees with Elija and Adedapo's [34] conclusion that the degree of domestic poultry performance is reliant not only on the genetic ability of the bird but also on the most significant environmental factors.

Table 4: Impact of climatic variables on backyard poultry production (n=232)

Climate variables	Very severe (%)	Severe (%)	Moderately severe (%)	Not severe (%)	Total	Average	Ranking
Temperature	64.2	16.8	12.5	6.5	232	3.39*	Critical
Rainfall	65.9	19.0	9.5	5.6	232	3.45*	Critical
Wind speed	17.7	16.4	36.2	29.7	232	2.22	Not critical
Sunshine	22.4	37.9	14.7	25.0	232	2.58*	Critical
Evaporation	6.5	25.0	23.3	45.3	232	1.93	Not critical
Humidity	38.4	44.0	12.1	5.6	232	3.15*	Critical

Note: * = Significant impact if mean score is ≥ 2.5

Source: field survey, 2021

3.7 Farmer's perceptions of climate change impacts on backyard poultry production

The research examined how the Farmer perceived climate change impacts their backyard poultry production (Table 5). The majority of the farmers ($\bar{x}$ = 4.11) perceived that climate change increased the spread of poultry diseases and increased feed costs ($\bar{x}$ = 3.99). The findings are comparable to Adesiji et al. [35], who reported that climate change hurts feed grain output and availability. According to Mengesha [36], climate change has intensified human-animal food-feed competition, demanding alternative poultry feed components. Most farmers ($\bar{x}$ = 3.92) perceived that climate change reduces the quantity of egg production, and increases the bird's intake of water ($\bar{x}$ = 3.72), at the same time, increasing birds' mortality rate ($\bar{x}$ =3.41). The findings are in accord with Ravichandran and Mohamed [37], who discovered that rising temperatures reduce egg size, drop rate, and meat, resulting in lower poultry production. According to Chah et al. [38], increasing temperatures affect chicken farming operations. Adejoro [39] indicates that climate change causes heat stress, failing vaccines, greater rearing mortality, poor productivity, and disease outbreaks in poultry production.

Table 5: Perceptions of the impacts of climate change on backyard poultry production (n=232)

Perception of the impact of climate change on poultry production	Strongly agree (%)	Agree (%)	Neither agree nor disagree (%)	Disagree (%)	Strongly disagree (%)	Total	Mean
Increased spread of poultry diseases	58.6	12.5	13.8	11.6	3.4	232	4.11*
Reduced quantity of egg production	48.7	20.3	11.2	13.8	6.0	232	3.92*
Reduction in quality and size of eggs	10.8	14.2	28.4	35.3	11.2	232	2.78
Loss of weight affecting meat production	14.7	43.5	10.8	19.8	11.2	232	3.31*
Increase in cost of feeding	55.2	12.5	17.7	5.6	9.1	232	3.99*
Increase in water intake	11.6	63.8	11.2	11.6	1.7	232	3.72*
Increased mortality rate of birds	13.8	44.8	20.3	10.8	10.3	232	3.41*

Note: * = Significant impact if mean score is ≥ 3.0

Source: field survey, 2021

3.8 Cluster analysis

Clustering analysis was carried out to classify the impact of climate change on backyard poultry production. The cluster analysis simulation procedure assigned respondents to three clusters, resulting in the frequency of farmers' occurrence in each cluster (Table 6). An elbow test confirmed the appropriate number of clusters according to Köbrich et al. [40] interpretation of the Dendrogram.

Table 6: Farmer's frequencies and percentages in the three clusters (n=232)

Clusters	Frequency	Percentage
1	135	58.2
2	43	18.5
3	54	23.3

Source: Authors computation, 2021

Cluster 1 - Increased poultry disease occurrences had the highest mean score ($\bar{x}$ = 4.64), substantially higher than the second and third clusters. This shows that farmers in this cluster encounter more difficulties with the prevalence of poultry diseases than farmers in other groups.

Cluster 2 – The mean score for decreased egg production was the highest ($\bar{x}$ = 5.00). This mean score was much higher than the mean ratings for the other clusters' feeding costs, significantly impacting poultry producers.

Cluster 3 – Perception of increasing feeding costs likewise got the cluster's highest mean score ($\bar{x}$ = 3.44). However, the mean score was lower than obtained in the first cluster, indicating that respondents in the first cluster did not perceive this impact as severe.

Table 7: Mean scores calculated for all items in the three clusters.

Perception of climate change impact on poultry production	Cluster 1 Increased spread of poultry diseases	Cluster 2 Reduced quantity of egg production	Cluster 3 Increase in cost of feeding
Increased spread of poultry diseases	4.64	4.26	2.75
Reduced quantity of egg production	4.39	5.00	1.89
Reduction in quality and size of eggs	3.50	1.67	1.85
Loss of weight affects meat production	4.10	1.67	2.63
Increase in cost of feeding	4.61	2.63	3.44
Increase in water intake	4.18	3.63	2.65
The increased mortality rate of birds	4.24	2.05	2.43

Source: Authors computation, 2021

3.9 Adaptive approaches for backyard poultry production in response to climatic change

The results of Table 8 on adaption strategy show that the majority of farmers (95.7%) chose the approach of appropriate water supply as their preferred option. Farmers hope that providing enough water for the birds will enable them to tolerate difficult circumstances such as excessive heat without becoming fatigued. As an adaptive approach, other farmers (75.9%) are boosting the number of supplemental feeds. The majority of the farmers (71.6%) use bird vaccination as an adaptation method. Raising different varieties of birds is practiced by some to the tune of (64.7%) of the backyard poultry farmers. This corroborates Hoffman's [41] assertion that a genetically diversified livestock population enables farmers to pick novel breeds created to address the dangers posed by changing climatic conditions. Most farmers (53.9%) used improved poultry breeds as an adaptation approach. This is consistent with Chah et al. [38], who noted that while unimproved breed stocks perish, resistant poultry birds thrive and complete their life cycles under climatic stress.

Table 8: Adaptive approaches for backyard poultry production response to climatic variance (n=232)

Mitigation Strategies	Frequency	Percentage	Ranking
Using improved poultry breeds	125	53.9	5
Rearing different varieties of birds	150	64.7	4
Construction of buildings with a sound ventilation system	89	38.4	8
Planting fast-growing trees to provide shade for the birds	112	48.3	6
Installing a cooling system in buildings	56	24.1	9
Vaccination of birds	166	71.6	3
Increased use of veterinary services	103	44.4	7
Adequate water supply	222	95.7	1
Increased quantity of supplementary feeds	176	75.9	2

* Responses are not 100% due to multiple responses of the respondents.
Source: field survey, 2021

4. CONCLUSION

The backyard poultry farmers in the study area were largely illiterate (59.5%) and reliant on conventional methods of managing their backyard poultry production. In the absence of fundamental knowledge on climate change, poultry farmers rely exclusively on their personal experience (43.5%), with only a small number benefiting from other sources such as radio, fellow farmers, and family members. The logistic regression analysis discovered that their gender ($p<0.004$) and climate information sources ($p<0.043$) positively influence farmers' knowledge of climate change. The poultry farmers (96.6%) are fully aware of climate change's impact on their backyard chicken production. The farmers perceived climate variables such as increased temperature, humidity, and sunshine as affecting backyard poultry production in the study area. Some perceived consequences included an increase in the water intake of birds, an increase in the incidence of poultry diseases, a reduction in the number of eggs produced, a decrease in the quality and size of eggs, a reduction in the weight of birds affecting meat production, and an increase in the mortality rate of birds. Adequate water availability, an increase in the quantity of additional feed, vaccination of birds against poultry diseases, and improved chicken breeds were some adaptation methods practices by the farmers.

Therefore, it is vital to improve the access of poultry farmers to climate change knowledge through extension services, which will raise the likelihood that farmers will become more aware of and adopt specific adaptation strategies to climate change. Rural poultry farmers' vaccination of their flocks is another crucial adaptive response that must be supported. This is especially crucial given vaccination's critical role in preventing and controlling poultry diseases.

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