ANALYSIS OF FACTORS INFLUENCING THE ADOPTION OF CLIMATE-SMART POULTRY PRACTICES BY BROILER FARMERS IN NIGER STATE, NIGERIA

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ABSTRACT

This study examined factors influencing the adoption of climate-smart poultry practices in Niger State, Nigeria, using data from 171 broiler farmers selected through a multistage sampling technique. Data collection was conducted via a structured online questionnaire and analyzed using descriptive statistics and a Multivariate Probit Model. Results show that respondents were predominantly young (mean age of 34 years), with 63.7% married and an average household size of five. Most farmers (98.2%) had formal education and an average of five years of farming experience, with 61.4% engaging in poultry farming for both household consumption and commercial purposes. The most adopted climate-smart practices were energy usage (98.2%) and proper housing (95.3%), while integrated farming (62.0%) was the least adopted. Weather-related losses were reported by 70.2% of respondents. Multivariate Probit Analysis revealed significant determinants of adoption. Age, education, gender, farming experience, household size, location, training, access to boreholes, labour availability, off-farm jobs, and extension services significantly influenced the adoption of practices such as ventilation, proper housing, integrated farming, energy usage, and litter management. Lack of capital emerged as the most critical constraint to adoption. To enhance adoption levels, the study recommends increased extension services to create awareness and improved access to credit facilities, grants, subsidies, and policy interventions addressing key adoption determinants. These efforts are essential to bolster farmers' resilience to climate challenges and promote sustainable poultry production in the study area.

Keywords: Climate Smart Practices, Climate change, Poultry, Broiler, Farmers

INTRODUCTION

The increasing demand for animal protein is directly linked to the ever-growing world population, highlighting the importance of efficient poultry production (Tona, 2018). Unfortunately, heat stress associated with climate change hinders these birds from reaching their inherent growth potential, resulting in productivity levels in Africa that are often below those achievable in cooler climates (Abioja and Abiona, 2020). Commercial broiler chickens (both males and females) are raised solely for meat production, although males grow faster than their female counterparts (Abioja and Abiona, 2020). The health of broiler chickens is significantly affected by environmental factors such as excessive humidity, airflow, and temperature. Among these stressors, heat stress caused by high temperatures is the most critical and is worsening due to ongoing global climate changes (Livingston et al., 2022). Heat stress negatively impacts feed consumption, feed efficiency, body mass index, meat quality, and mortality rates (Livingston et al., 2022). Proper management of these environmental stressors is essential for the optimal development and general well-being of broiler chickens.

Fast-growing broiler chickens are particularly susceptible to heat stress during the growing-finishing stage. As they age, their metabolic heat production increases due to high feed intake and rapid growth rates. Moreover, several processes involved in broiler chicken production directly and indirectly contribute to greenhouse gas emissions (Herrero et al., 2016). Studies have shown that the performance of broiler chickens is influenced by environmental conditions such as rainfall, temperature, relative humidity, and sunshine. Additionally, housing systems, poultry house ventilation, and other management practices have, in recent times, negatively impacted poultry farming (World Bank Group, 2023).

Adopting climate-smart poultry production practices is a viable strategy to boost output while addressing the challenges posed by climate change (Long et al., 2016; Onada and Ogunola, 2016). According to Ifabiyi et al. (2024), the adoption of these practices by poultry farmers would enhance productivity and build resilience to mitigate the effects of climate alterations. Climate change presents a significant threat to broiler production, necessitating the adoption of smart approaches to reduce its impact on broiler birds and lower greenhouse gas emissions from broiler production activities, which contribute to global warming. However, various factors can either positively or negatively influence the adoption of these smart practices.

There is limited information on the use of climate-smart poultry practices and the factors affecting their adoption in the study area. This gap forms the basis of this study, emphasizing the need to assess the factors influencing the adoption of climate-smart practices by broiler farmers in Niger State.

Objectives of the Study

This research aims to analyze the factors influencing the adoption of climate-smart poultry practices by broiler farmers in Niger State. Specifically, the objectives are to:

i. Identify the climate-smart poultry practices employed by broiler farmers.
ii. Determine the factors influencing the adoption of climate-smart poultry practices by broiler farmers in Niger State.
iii. Examine the constraints faced by broiler farmers in adopting climate-smart poultry practices in the study area.

METHODOLOGY

The study area is Niger State, located between Longitude 3° 30' and 7° 20' East and Latitude 8° 20' and 11° 30' North. Niger State has an estimated human population of approximately 3,950,249. Based on an annual growth rate of 3.2%, the population was estimated to have reached 5,586,000 as of 2017 (Niger State Geographical Information System [NIGIS], 2015). The state comprises 25 constitutionally administered Local Government Areas (LGAs) and is divided into three agricultural zones: Zone I: Headquarters in Bida; Zone II: Headquarters in Kuta; and Zone III: Headquarters in Kontagora.

A multistage sampling technique was employed to select the sample for the study. In the first stage, the three agricultural zones were selected. In the second stage, two LGAs were purposively selected from each zone, totaling six LGAs: Lapai, Bida, Bosso, Chanchaga, Borgu, and Wushishi. These LGAs were chosen due to the prevalence of broiler farmers. In the third stage, a 35% proportionate sample size from each selected LGA was determined, considering the relatively small sample frame. Finally, broiler farmers were randomly selected across the selected LGAs. Primary data was collected using a structured online questionnaire. Face-to-face interviews were conducted with the assistance of well-trained enumerators to ensure accuracy and completeness of the data collection process.

Table 1: Zonal and LGA representation of the broiler farmers

State	Zone	LGAs	Sampling Frame	Sample (35%)
Niger state	Zone-1	Lapai	56	20
		Bida	76	27
	Zone-2	Bosso	132	46
		Chanchaga	104	36
	Zone-3	Borgu	54	19
		Wushishi	66	23
Sub-total	3	6	488	171

Source: PAN Niger state chapter, 2023.

Analytical techniques

Descriptive Statistics

Measures of central tendency, such as means, frequency distributions, and percentages, were used to summarize the socioeconomic profiles of broiler producers and address Objective I. Constraints faced by broiler farmers in adopting climate-smart poultry practices (Objective III) were analyzed using frequency, percentage, and ranking.

Multivariate Probit Model

The factors influencing the adoption of climate-smart poultry practices were analyzed using a multivariate probit model. This model was employed to achieve Objective II, following the approach of Aryal et al. (2018). The multivariate probit model accounts for the likely correlation between the decision to adopt one practice and the decision to adopt others. Farmers are often more likely to adopt a combination of climate-smart practices simultaneously or sequentially, either as complements or supplements. The model is specified as:

$$y^{*} = \beta_m + X_{im} + \varepsilon_{im} \qquad m = (1, 2, 3, 4, 5) \qquad (1)$$

$$y = 1 \; if \; y^{*}_{im} > 0$$
$$0 \; otherwise \qquad (2)$$

Where y^*_{im} is a latent variable that captures the unobserved preferences associated with the choice of practice m. This latent variable is assumed to be a linear combination of observed characteristics, X_{im}, and unobserved characteristics captured by the stochastic error term, ε_{im}. The vector of parameters to be estimated is denoted by β_m. Given the latent nature of y^*_{im}, estimation is based on observable binary variables y_{im}, which indicate whether or not a farmer used a particular climate-smart poultry practice. The error terms ε_{im}, m = 1,2,3,4,5 are distributed multivariate normal each with mean 0 and a variance-covariance matrix V, where V has 1 on the leading diagonal, and correlations $\rho_{jk} = \rho_{kj}$ as off diagonal elements (Cappellari & Jenkins 2003)

$$V = \begin{pmatrix} 1 & p12 & p13 & . & . & p1k \\ p21 & 1 & p23 & . & . & p2k \\ p31 & p32 & 1 & . & . & p3k \\ . & . & . & 1 & . & p4k \\ . & . & . & . & 1 & p5k \\ pj1 & pj2 & pj3 & pj4 & pj5 & 1 \end{pmatrix} \quad (3)$$

Where p (rho) denotes the pairwise correlation coefficient of the error terms corresponding to any two climate-smart practices adoption equations to be estimated in the model (Kassie *et al.*, 2015). In the presence of error terms correlation (p), the off-diagonal elements in the variance–covariance matrix of adoption equations become non-zero and Eq. (2) becomes a MVP model. In this model, p is not just a correlation coefficient and carries more information. A positive correlation is interpreted as a complementary relationship, while a negative correlation is interpreted as being substitute.

Table 2: Measurement and apriori expectation of the variables used in the model

Variables	Measurement	Expected sign
Dependent variables	1=ventilation, poultry pen building, integrated farming, energy usage and litter management, 0 otherwise	
Independent variables		
Age	Years	+
Sex	Dummy(1=Male, 0=female)	+/-
Education	Years	+
Household size	Number of people living under the same roof	+/-
Farming experience	Years	+
Received training	Dummy variable(1= yes, 0= no)	+
Membership of cooperatives	Dummy variable(1= yes, 0= no)	+
Extension contact	Dummy variable(1= yes, 0= no)	+
Purpose of farming	Dummy variable(1= commercial, 0=household consumption)	+
Access to credit	Dummy variable(1= access, 0=no access)	+
Location	Dummy variable(1= urban, 0=rural)	+/-
Farm scale	Number of chicks x cost of chicks	+
Rent	cost (Naira)	-
Own well or borehole	Dummy variable (1=yes, 0= no)	-
Labor	Dummy variable (1=family labor, 0=hired labor)	+/-
Off farm jobs	Dummy variable (1=yes, 0=no)	+
Experience loss	Dummy variable (1=yes, 0=no)	+

RESULTS AND DISCUSSION

Socio-economic characteristics of the broiler farmers

The findings revealed that 67.3% of broiler farmers in the study area were male, while 32.8% were female, indicating higher male participation in broiler farming. However, there is still significant female participation. This aligns with Tsado et al. (2018), who reported that 91.7% of broiler farmers in Niger State were male, highlighting male dominance in the poultry industry. The mean age of the farmers was 34.2 years, suggesting that economically active individuals dominate broiler farming in the study area. This agrees with Tsado et al. (2018), who found that 93.3% of poultry farmers in Niger State were aged 21–50 years, with a mean age of 35 years. Regarding marital status, 63.7% of the farmers were married, 33.9% were single, and 1.2% were divorced or widowed, respectively. This shows that most respondents have family responsibilities, which may influence their decision-making in farming. These findings align with Umunna et al. (2021), who reported that 64.4% of indigenous chicken farmers in Niger State were married, while 20.5% were single.

Table 3: Summary statistics of socioeconomic profiles of broiler farmers

Variables	Categories	Frequency	Percentage	Mean	SD
Gender	Male	115	67.3		
	Female	56	32.8		
Age	≤40	133	30.3	34.2	9.5
	>40	38	48.1		
Marital status	Divorced	2	1.2		
	Married	109	63.7		
	Single	58	33.9		
	Widow(er)	2	1.2		
Marital status	Married	109	63.7		
	Unmarried	62	36.3		
Household size	>12	4	14.8	5.0	2.9
	≤12	167	4.8		
Education(formal)	Years	Min(2)	Max(23)	13	5
Off farm jobs	Agric-Trading	30	17.5		
	Civil servant	28	16.4		
	Crop farmer	36	21.1		
	Non-agric business	33	19.3		
	Professional	11	6.4		
	Retiree	4	2.3		
	Student	25	14.6		
	working for other farmers	2	1.2		
	None	2	1.2		
Farming exp.	>5	44	11.3	4.9	4.6
	≤5	127	2.7		
Purpose of farming	Commercial	61	36.67		
	Household consumption	5	2.92		
	Household consumption and commercial	105	61.40		
Loss from harsh weather	No	51	29.8		
	Yes	120	70.2		

Source: Field survey data 2023

The average household size was five persons, which can be advantageous by reducing labor costs through family labor. However, this household size is smaller compared to Umunna et al. (2021), who reported an average of nine persons per household, indicating a relatively smaller family size in the current study. The study found that broiler farmers had formal education, with an average of 13 years of schooling, indicating high literacy levels. This aligns with Umunna et al. (2021), who also found high literacy rates among indigenous chicken farmers. Literate farmers are more likely to adopt policies and technologies due to their ability to comprehend information effectively (Ahmed, 2022).

In addition to broiler farming, 84% of the respondents were engaged in other occupations, such as crop farming, non-agricultural businesses, agricultural trading, civil service, professional work, or retirement activities. The farmers had an average of five years of practical experience in broiler farming. This indicates a reasonable level of experience in broiler production, although it is lower than the findings of Tsado et al. (2018), who reported that 71.7% of broiler farmers had 6–10 years of experience, with an average of seven years.

The study revealed that 36.67% of broiler farmers in the study area farmed for commercial purposes, 2.92% for household consumption, and 61.40% for both purposes. This indicates that most farmers are profit-oriented and are likely to adopt climate-smart poultry practices to protect their investments. These findings corroborate Ifabiyi et al. (2024), who found that 68.0% of poultry farmers engaged in farming for both consumption and commercial purposes. Approximately 70.2% of broiler farmers in the study area experienced losses due to weather events, while 29.8% did not. This suggests that a significant proportion of farmers have faced climatic challenges, which may encourage them to adopt climate-smart poultry practices.

Climate-smart Poultry practices adopted by respondents

The climate-smart poultry practices adopted by respondents as presented in Table 3 include ventilation, proper housing, integrated farming, litter management, and energy usage. The majority of respondents (98.2%) use LED lights and solar energy, demonstrating a high adoption rate of climate-smart energy solutions. This finding aligns with Osuji et al. (2024), where 64.1% of farmers adopted energy-efficient bulbs. Good spacing (73.1%) and strategic building plans (15.8%) are the most common housing practices. Osuji et al. (2024) reported that all poultry farmers in their study adopted proper housing systems. According to Salem et al. (2022), proper housing facilitates ventilation, cleaning, adequate spacing, and disease prevention in poultry pens. Daily litter management is practiced by 54.4% of respondents, followed by litter changes every 2–7 days (32.8%). Liverpool-Tasie et al. (2019) found that frequent litter changes during heat periods are negatively correlated with heat buildup in poultry farms. Sprinkler systems (31.6%) and pen roofing (26.9%) are the most commonly adopted ventilation practices. This supports the findings of Osuji et al. (2024), who noted the adoption of adequate ventilation measures. Olutumise (2023) explained that proper ventilation reduces heat stress in poultry pens, contributing to improved bird health.

Poultry-crop farming (52.6%) is the most common integrated farming practice. Bird droppings, rich in nitrogen and phosphorus, are used as manure, reducing methane buildup and benefiting crop production. In return, farm produce is used as poultry feed components. Poultry-fish farming, adopted by only 9.4% of respondents, offers advantages such as a cooler environment for birds during warm periods and access to water (Liverpool-Tasie, 2019). Additionally, chicken manure serves as an efficient fertilizer in fish farming.

Factors influencing the adoption of climate-smart poultry practices

Using a likelihood ratio test, the null hypothesis of zero correlation between the error terms is rejected (χ^2 (10) = 35.82, probability > χ^2 = 0.0001). This indicates that there are statistically significant correlations among the adoption of different climate-smart poultry practices. Of the 10 pairs of climate-smart poultry practices, six correlation coefficients are statistically significant, suggesting interdependence among the practices. A negative correlation between two practices implies that farmers view these practices as substitutes or find one more suitable for climate adaptation. A positive correlation suggests complementarities, where the adoption of one practice supports the adoption of another.

Positive interdependencies were observed between the following pairs of practices: proper housing and ventilation (p21), integrated farming and ventilation (p31), energy usage and ventilation (p41), integrated farming and proper housing (p32), energy usage and proper housing (p42), energy usage and integrated farming (p43). All correlations except for p43 were significant at the 1% probability level, while p43 was significant at the 5% level. These findings imply that broiler farmers perceive these practices as complementary, adopting them jointly to enhance resilience to climate change. Differences in climate-smart adoption behavior among broiler producers were reflected in the likelihood ratio statistics of the estimated correlation matrix. The degree of correlation between each pair of dependent variables highlights the nuanced decision-making process of farmers when adopting climate-smart practices.

The results show that the model fits the data well, as the Wald chi² (73) = 146.40, $p>\chi2=0.0000p>\chi2=0.0000$, is significant at the 1% level. This indicates that the subset of coefficients of the model is jointly significant and that the explanatory power of the factors included in the model is satisfactory. Thus, the MVP model fits the data reasonably well. Eight variables significantly affected ventilation; five variables significantly affected proper housing; seven variables significantly affected integrated farming systems; three variables significantly affected energy usage; and six variables significantly affected litter management.

Table 4: Climate-smart poultry practices adopted by broiler farmers

Climate smart poultry practices	Categories	Freq.	Percentage	Ranking
Ventilation	Fan	23	13.5%	
	pen roofing	46	26.9%	
	Sprinkler	54	31.6%	
	Ice block	3	1.8%	
	Open ventilation	22	12.9%	
	None	23	13.5%	
	Total adopters	**148**	**86.7%**	4th
Proper housing	Good spacing	125	73.1%	
	Insulation	11	6.4%	
	Strategic building plan	27	15.8%	
	None	8	4.7%	
	Total adopters	**163**	**95.3%**	2nd
Integrated farming	poultry-fish farming	16	9.4%	
	poultry-crop farming	90	52.6%	
	None	65	38%	
	Total adopters	**106**	**62.0%**	5th
Litter management	2-7 days	56	32.8%	
	8-10 days	7	4.1%	
	Daily	93	54.4%	
	Weekly	15	8.7%	
	Total adopters	**149**	**87.2%**	3rd
Energy usage	LED light (electricity)	98	57.3%	
	Solar energy	70	40.9%	
	None	3	1.8%	
	Total adopters	**168**	**98.2%**	1st

Source: Field survey data 2023/2024.

The multivariate probit results show that the factors influencing the adoption of climate-smart poultry practices vary significantly across practices. Table 6 reveals that age was statistically significant in predicting the adoption of ventilation systems, proper housing, integrated farming, and litter management, all at a 10% significance level, except for proper housing, which was significant at a 1% level. According to the results, a one-year increase in the average age of the farmer is associated with a 0.040 decrease in the odds of adopting a ventilation system but a 0.104, 0.038, and 0.042 increase in the odds of adopting proper housing, integrated farming, and litter management, respectively. Older respondents are more likely to adopt proper housing, integrated farming, and litter management. This is possibly because older respondents are more experienced and knowledgeable about the effects of climate change. This finding aligns with the study by Osuji et al. (2024), which reported that age positively and significantly influenced climate change adaptation.

Table 5: Estimated correlation matrix and overall fitness

	p_1	p_2	p_3	p_4	p_5
P_1	1				
p_2	0.949(0.049)***	1			
p_3	0.662(0.143)***	0.679(0.126)***	1		
p_4	0.519(0.148)***	0.681(0.128)***	0.519(0.176)**	1	
p_5	0.141(0.153)	0.248(0.159)	0.099(0.156)	-0.059(0.178)	1

Likelihood ratio test of $p_{21} = p_{31} = p_{41} = p_{51} = p_{32} = p_{42} = p_{52} = p_{43} = p_{53} = p_{54} = 0$
X2 (10) = 35.8238

Prob > X^2 = 0.0001***

Number of draws (#)	5
Number of observations	171
Wald (x2(73))	146.4
Prob > X2	0.0000***

Note: ** and *** significant at 5 and 1% respectively

Gender was a significant factor determining the adoption of climate-smart proper housing. The positive coefficient of 1.216 indicates that male respondents are more likely to adopt climate-smart proper housing than female broiler farmers at a 1% significance level. This could be attributed to male farmers having more access to inputs such as capital and credit than their female counterparts. This finding aligns with the study by Arya et al. (2018), which found that male-headed households are more likely to adopt laser land leveling (LLL).

Household size was statistically significant in predicting the adoption of integrated farming systems and litter management at 5% and 10% significance levels, respectively. A one-unit increase in household size among broiler farmers is associated with a 0.136 and 0.104 decrease in the odds of adopting integrated farming systems and litter management, respectively. This aligns with the study by Alalade et al. (2022), which revealed that household size increases the probability of adopting CSA practices.

Years of education were statistically significant in predicting the adoption of climate-smart ventilation and proper housing at 1% and 5% significance levels, respectively. A unit increase in the number of years of education increases the odds of adopting ventilation by 0.111 but decreases the odds of adopting proper housing by 0.103. This implies that farmers with more years of education are more likely to adopt ventilation, while farmers with fewer years of education or those who are illiterate unexpectedly have higher odds of adopting proper housing. This finding aligns with Alalade et al. (2022), who confirmed that education positively and significantly influenced the adoption of CSA practices. Time invested in education enables respondents to understand the importance of using climate-smart practices.

Table 6: Estimates of the multivariate probit model

Variables	Vent	PH	IF	Eg	LM
Socioeconomic characteristics	**Coeff(se)**	**Coeff(se)**	**Coeff(se)**	**Coeff(se)**	**Coeff(se)**
Age	-0.040*	0.104***	0.038*	-0.012	0.042*
	(0.023)	(0.028)	(0.018)	(0.013)	(0.021)
Gender	-0.275	1.216***	0.074	-0.137	-0.003
	(0.373)	(0.333)	(0.277)	(0.230)	(0.296)
Household size	0.105	0.044	-0.136**	-0.010	-0.104*
	(0.079)	(0.049)	(0.049)	(0.045)	(0.052)
Education (year)	0.111***	-0.103**	0.006	0.018	0.022
	(0.028)	(0.036)	(0.026)	(0.023)	(0.026)
Farming experience	-0.083*	-0.065*	-0.079*	0.029	-0.063*
	(0.035)	(0.039)	(0.038)	(0.026)	(0.036)
Farm land characteristics					
Rent	0.00001	-----	-0.000007	-0.000008	-0.000002
	(0.00002)	-----	(0.00001)	(0.000008)	(0.000008)
Own well or borehole	-0.639*	-----	-1.183***	-----	0.289
	(0.335)	-----	0.280	-----	(0.266)
Number of laborers	0.235*	-----	0.308*	0.104	-0.091
	(0.134)	-----	(0.127)	(0.095)	(0.100)
Farm scale	-0.000002	-----	0.000004	0.000001	0.0000008
	(0.000002)	-----	(0.000003)	(0.000002)	(0.000002)
Purpose of farming	-0.237	-1.194	-0.647	-----	-----
	(0.799)	(136)	(0.639)	-----	-----
Location	-----	0.432	0.938**	-----	0.595*
	-----	(0.345)	(0.302)	-----	(0.340)
Off-farm jobs	-0.133	-----	0.722*	0.102	0.836 *
	(0.429)	-----	(0.361)	(0.328)	(0.383)
Experience loss	0.516	0.112	0.280	-0.467*	-0.106
	(0.347)	(0.278)	(0.302)	(0.223)	(0.293)
Receive training	-0.917*	0.517*	-0.278	-0.599**	0.687*
	(0.395)	(0.259)	(0.304)	(0.222)	(0.304)
Institutional factors					
Member of	-1.270*	----	-0.456	0.286	0.151
association	(0.560)	----	(0.471)	(0.402)	(0.447)
Extension service	1.577*	----	0.136	-0.806*	-0.699
	(0.815)	----	(0.484)	(0.442)	(0.487)
Access to credit	0.345	0.740	0.470	0.322	-0.031
	(0.832)	0.972	(0.560)	(0.382)	(0.464)
Constant	2.021*	-0.114	-0.708	0.475	-0.856
	(1.052)	(136)	(0.947)	(0.528)	(1.038)
No. of observation	171	171	171	171	171

Source: Field survey data 2023

Notes: Vent; ventilation, BD; proper housing, IF; integrated farming, EG; energy usage, LM; litter management. *, **, and *** are significance level at 10%, 5%, and 1%, respectively. Standard errors are reported in parentheses.

Farming experience was a significant factor in adopting ventilation, proper housing, integrated farming, and litter management. The negative coefficients (-0.083, -0.065, -0.079, and -0.063, respectively) surprisingly reveal that respondents are less likely to adopt these practices at a 10% significance level. A unit increase in years of farming experience decreases the odds of adopting ventilation, proper housing, integrated farming, and litter management. A possible explanation is that broiler farmers with less experience might already be familiar with these smart practices. This aligns with the study by Alalade et al. (2022), which found that farming experience positively influenced the adoption of CSA practices.

Owning a well or borehole was a significant factor in determining the adoption of ventilation and integrated farming. The negative coefficients (-0.639 and -1.183, respectively) indicate that respondents are less likely to adopt ventilation and integrated farming at 10% and 5% significance levels, respectively. This suggests that farmers who own a well or borehole are less likely to adopt integrated farming and energy usage. In practice, a lack of ownership of a well or borehole reduces the likelihood of adopting integrated farming, as such systems require significant water, which, if not owned, increases the cost of production. This finding aligns with Liverpool-Tasie et al. (2019), who reported that owning a well or borehole significantly influences the adoption of litter spreading and traditional practices.

The number of laborers had a positive influence on the adoption of ventilation and integrated farming. A unit increase in the number of laborers increases the probability of adopting ventilation and integrated farming, both at a 10% significance level. Specifically, an increase in the number of laborers is associated with a 0.235 and 0.308 increase in the odds of adopting ventilation and integrated farming, respectively. This implies that farmers with larger numbers of laborers are more likely to adopt ventilation and integrated farming systems. This is logical, as poultry-fish farming and poultry-crop farming are labor-intensive and cannot be effectively managed with few workers.

Location was statistically significant in predicting the adoption of climate-smart integrated farming and litter management, significant at the 5% and 10% levels, respectively. The positive coefficients of 0.938 and 0.595 indicate that farmers in urban areas are more likely to adopt integrated farming and litter management. This is expected, as urban farmers are closer to advanced technologies and developmental resources.

Off-farm jobs were significant in influencing the adoption of both integrated farming and litter management, with positive coefficients of 0.722 and 0.836, respectively, both at a 10% significance level. Respondents engaged in off-farm jobs are more likely to adopt these practices due to additional income, enabling farm integration and employment of labor to manage litter effectively. This aligns with Liverpool-Tasie et al. (2019), who reported that off-farm jobs positively influence the adoption of adaptation strategies by poultry farmers.

Experience of loss was significant in determining the adoption of energy usage. A negative coefficient of 0.467 indicates that a unit increase in farmers experiencing loss from extreme weather decreases the odds of adopting climate-smart energy usage. This suggests that farmers who experience losses from heat or harsh weather are less inclined to adopt energy-saving measures, consistent with Liverpool-Tasie et al. (2019).

Training was positively associated with the adoption of proper housing and litter management (both at a 10% significance level), with coefficients of 0.517 and 0.687, respectively. However, it was negatively associated with ventilation (10%) and energy usage (5%), with coefficients of 0.917 and 0.599. This implies that trained farmers are more likely to adopt proper housing and litter management but less likely to adopt ventilation and energy usage. Training enhances awareness and understanding of climate-smart practices, consistent with Aryal et al. (2018).

Membership in an association negatively influenced the adoption of ventilation systems, with a coefficient of 1.270 at a 10% significance level. Farmers who are not association members are more likely to adopt ventilation, which is unexpected since associations often provide forums for awareness and education. Nevertheless, this result aligns with Liverpool-Tasie et al. (2019), who found that membership in poultry farmer associations is linked to a higher likelihood of adopting ventilation and litter spreading.

Extension services significantly influenced the adoption of ventilation and energy usage, both at a 10% significance level. Farmers who accessed extension services were more likely to adopt ventilation systems (1.577) but less likely to adopt energy usage (0.806). This indicates that extension agents promote awareness of ventilation systems but less so for energy-saving measures. Aryal et al. (2018) similarly found variable effects of extension services on technology adoption. Other factors such as rent, farm scale, purpose of farming, and access to credit were not significant in predicting the adoption of any climate-smart poultry practices.

Constraints in Climate-Smart Poultry Practices Adoption

Table 7 highlights capital as the most severe constraint affecting all climate-smart practices, including ventilation (32.8%), proper housing (46.8%), integrated farming (76.6%), and energy usage (40.4%). Maintenance costs were also severe, particularly for litter management (47.4%), energy usage (34.5%), and ventilation (5.9%). Moderately severe constraints included limited technology, high material costs, and water shortages. Power supply issues were less severe, affecting ventilation (15.2%) and integrated farming (7.6%). This calls for improved access to credit facilities for farmers.

Table 7: constraints in the adoption of climate-smart poultry practices

Climate smart practices	Categories	Frequency	percentage	Ranking
Ventilation	Capital	56	32.8%	1st
	High cost of materials	25	14.6%	4th
	Maintenance cost	10	5.9%	5th
	Limited technology	50	29.2%	2nd
	Power supply	26	15.2%	3rd
	Water shortage	4	2.3%	6th
building design	Capital	80	46.8%	1st
	Cost of rent	8	4.7%	4th
	No good architect	6	3.5%	5th
	Designing Cost	65	38.0%	2nd
	Others	12	7.0%	3rd
Litter Management	Maintenance cost	81	47.4%	1st
	Limited buyers	31	18.1%	3rd
	Limited technology	35	20.5%	2nd
	Others	24	14.0%	4th
Integrated farming	Capital	131	76.6%	1st
	Limited rainfall	7	4.1%	4th
	water shortage	13	7.6%	3rd
	Others	20	11.7%	2nd
Energy usage	Capital	69	40.4%	1st
	Maintenance cost	59	34.5%	2nd
	Sub-standard tools	13	7.6%	4th
	Others	30	17.5%	3rd

Source: Field survey data 2023

CONCLUSION AND RECOMMENDATIONS

The study concludes that respondents are productive, literate, predominantly male, and commercially oriented farmers with significant experience and household size. Most farmers simultaneously adopt multiple climate-smart practices, despite experiencing losses due to climate events. Factors influencing adoption vary across practices, with capital identified as the most critical constraint.

From the results, the following recommendations were made:

1. Broiler farmers should have access to extension services as extension agents create more awareness of the importance of climate-smart practices. This may lead to an increase in the adoption of these practices.
2. Policymakers and stakeholders should prioritize addressing capital constraints, such as providing access to credit, grants, or subsidies, to support farmers in adopting climate-smart practices.
3. Policies should be designed that will enhance factors that determine the adoption of climate-smart poultry practices in broiler farming has great potential to increase the use of these practices.

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