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Adoption of Climate Change Adaptation Strategies and Household Food Security of Smallholder Poultry Farmers in Lagos and Ogun states , Nigeria
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Abstract

This study assessed the effects of the adoption of climate change adaptation strategies (CCAS) on household food security among smallholder poultry farmers (SPFs). Using a multi-stage sampling approach, 360 smallholder poultry farmers were surveyed through a questionnaire. Percentages, mean score, and endogenous switching probit model (ESPM) were employed for analysis. The result revealed a significant negative influence for sex, age, infrastructure and access to credits, on the adoption decisions of CCAS for food security among SPFs. It further showed that SPFs could increase their food security by 1.923 if they adopted CCAS, whereas those in the adopter group would have 1.556 times more food security than if they did not adopt CCAS. Therefore, it is advised that policies be put in place to help SPFs make better choices regarding the use of CCAS, and these strategies should be included in policies and investment plans.

Introduction

Climate change is a threat to the entire world (Ogundeji, 2022). It significantly impacted food production and security, especially in developing nations (Eta et al., 2023). Globally, the impact of climate change has resulted in losses of more than $100 billion in livestock and crop production (FAO, 2015a). Increased temperatures and sea levels, shifting rainfall patterns, and shifting humidity are all signs of climate change (Seneviratne et al., 2021). Floods, droughts, and soil salinity are some of the secondary effects of climate change that negatively impact agriculture. According to reports, Africa is more likely to have negative effects (Guido et al., 2020; Ogundeji, 2022). In recent years, sub-Saharan African nations like Nigeria have seen seasonal and annual unpredictability in rainfall and temperature, which has had several detrimental repercussions on the sustainability of the agricultural industry (Guido et al., 2020).

According to the United States Agency for International Development (USAID, 2019), climate projections for Nigeria indicate an anticipated rise in temperatures ranging from 1.1 to 2.5°C by the year 2060. Furthermore, these projections foresee a notable escalation in the frequency of extreme heat days, reaching 260 by the year 2100, which stands in stark contrast to the recorded 10 days of extreme heat in 1990 (USAID, 2019). Abera et al. (2023), Eta et al. (2023), and Liverpool-Tasie et al. (2019) reported an increase in rainfall variability, dry spells within the rainy seasons, and amplified irregularities in precipitation levels after the onset of the rainy season. Nigeria is among the African nations where agricultural practices are significantly dependent on local weather conditions (Ogunpaimo et al., 2021). The country's changing climate is evident through instances of prolonged droughts, persistent flooding, heightened temperatures, increased humidity, and environmental degradation, all of which have contributed to a decline in agricultural production (Eta et al., 2023).

Factors such as limited land availability and constrained opportunities and the frequent and severe weather events induced by climate change would have a significant impact on the food security status of both rural and urban populations (Ogunpaimo et al., 2021). Within Nigeria's agricultural sector, poultry production stands out as a crucial segment. It does not only serve as a rich source of fats and vitamins but also plays a pivotal role in meeting protein requirements (Puglisi and Fernandez, 2022). However, despite the nutritional significance of poultry, the growing demand for chicken in the face of limited production capacity remains a challenge.

The current supply-demand imbalance is stark, with a gap of 1.2 million metric tonnes. Local demand stands at 1.5 million metric tonnes, while local farmers are only able to produce 300,000 metric tonnes (Adebisi et al., 2019). It is crucial to recognize that the impact of climate change on poultry production is intricately linked to these supply-demand dynamics, further complicating the nation's ability to meet the nutritional needs of its population. The detrimental impacts of climate change are already being felt by poultry and other livestock farmers. Increasing animal mortality and smaller herd sizes decreased livestock food supply (Godde et al., 2021). Climate change has resulted in a decline in available water supplies, decreased animal productivity due to reduced feed quantity and quality, and increased frequency and severity of new animal diseases. (Magiri et al., 2021; McCarthy et al., 2023). The influence of prolonged dry spells and high temperatures in Africa on poultry production has received little attention in the climate adaptation literature. However, it is evident that these climatic changes can directly and indirectly impact poultry production. The correlation between elevated temperature and heat stress and the decline in poultry production, including mortality, decreased egg production (both in quantity and quality), and slowed growth rate, has been established in intensive poultry farming systems prevalent in Africa and Asia (Onagbesan et al., 2023; Ghoname, 2022).

There are several aspects to food security, such as availability, accessibility, utilization, and stability. Accessibility is impacted by actual income, whereas availability refers to the total amount of food available. Poultry products (chicken meat and eggs) are perceived to be accessible within the study area due to the class of the population but negative incidences of climate change could make the products not available. Stability on the other hand is related to time, while utilization is related to fulfilling daily nutritional needs. Consequently, several factors, including low livestock food production, restricted land availability, and diminished opportunities, exacerbated by the escalating frequency and severity of weather events attributed to climate change, pose a formidable challenge to the household food security (HFS) status of both rural and urban populations. The potential effects of climate change on various factors, including accessibility, decline in household income or utilization (Birhanu et al., 2023) are consequences of food insecurity.

Based on the household survey of expenditures conducted in 2018/2019, approximately 40% of the population in Nigeria is classified as experiencing household food insecurity. This was influenced by the effects of climate change on the availability of agricultural production. In response to current or anticipated climatic changes and their effects on poultry farming and food security, necessary modifications must be considered to mitigate potential harm (Mbow et al., 2019; FAO, 2015b). The research gap in the existing literature lies in the insufficient exploration of the nuanced pathways through which smallholder poultry farmers (SPFs) in Southwest Nigeria, upon adopting climate change adaptation strategies, experience consequential impacts on their household food security. Current studies such as Nyoni et al. 2022, Nyang'au et al. 2021, Ogunpaimo et al. 2021, Karki et al. 2020, etc. lack a detailed examination of the specific mechanisms and contextual factors that mediate or hinder the effectiveness of these adaptation measures in ensuring sustained food security for SPFs. Addressing this gap is imperative for developing targeted interventions that consider the intricacies of the relationship between climate change adaptation strategies and household food security outcomes in the context of smallholder poultry farming in Nigeria. Therefore, this paper investigated the adoption of climate change adaptation

strategies by smallholder poultry farmers (SPFs) in Lagos and Ogun States, Southwestern Nigeria, and their consequential impact on household food security.

Methodology

Lagos and Ogun states were purposefully chosen due to the prevalence of smallholder poultry farming enterprises, a succession of poultry value chain market operations, and millions of different classes of consumers of poultry products (chicken and eggs). In addition, there are substantial trans-border poultry value chain business activities between the states and outside the country. A multistage sampling procedure was used to randomly select smallholder poultry farmers from the identified poultry farm clusters and poultry farm households within the communities in the study area. Stage one was a purposive selection of two agricultural zones from each state, Lagos (Ikorodu and Ojo) and Ogun (Ijebu and Ikenne). Stage two involved the purposive selection of two blocks (local government areas) from each zone, while three (3) communities (cells) were purposively selected from each block in the third stage. The fourth stage involved a random selection of 15 smallholder poultry farmers from each cell to make a total of 360 samples.

The adoption of CCAS for advantageous purposes is conceptualized within a random utility framework, as posited by Ojo et al. (2021). The variable CC_{i*} represents the level of satisfaction a household obtained from adopting CCAS. Thus, a household 'i' can be considered an adopter of CCSA if the value of CC_{i*}, which is calculated as the difference between CC_{1i*} and CC_{0i*}, is greater than zero. However, the difference is not directly observable. Nonetheless, it can be represented through a latent variable model in Equation 1:

$$CC_{i*} = \omega M_i + \varepsilon_i > 0, \text{ where } CC_i = 1 \text{ if } CC_{i*} > 0. \quad (1)$$

Here, CC_i represents whether a smallholder poultry farmer had adopted CCAS, with a value of '1' indicating adopting and a value of '0' indicating not adopting. The vector 'Mi' pertains to a set of variables, such as age, sex, marital status, religion, household size, years of schooling, average capacity/cycle, types of poultry enterprise, experience, purpose of rearing, and specific products of CCAS, that exert an influence on adopting CCAS. Simple regression was used to estimate the impact of CCAS on household food security, because of the non-random nature of households' decisions to adopt CCAS. Households, who adopt CCAS may possess distinct characteristics compared to those who did not adopt CCAS (Marcos and Duncan, 2019). Smallholder poultry farmers with additional skills, abilities, and motivation through access to credit, extension services, or membership in cooperative groups adopt CCAS, whereas those with limited resources and weaker networks did not adopt CCAS. However, in examining the consequences of climate change adaptation strategy adoption on the household food security of smallholder poultry farmers, the study incorporates relevant factors influencing farmers' decision-making processes. The food security of poultry farmers is represented as a latent variable in Equation 2.

$$G_{i*} = \beta W_i + \lambda CC_{i*} + \mu_i > 0, \text{ where } G_i = 1 \text{ if } G_{i*} > 0. \quad (2)$$

Where:-

Gi^* = latent construct denoting the inclination of household 'I' towards being food secure.

$Gi^* = 0$ when the farmer is not food secured

Gi^* = 1 when the farmer is food secured
μ_i = observable characters
CC_i = binary choice of CCAS adoption
β_1 and λ = estimated parameters

Observable characters:
X_1 = Age (19-38, 39-58>=59),
X_2 =Sex (male and female),
X_3 = Marital status (married and single)
X_4 = Household size (– <= 5 and >= 6),
X_5 = Years spent schooling (1-5, 6-11, 12-16 and >= 17),
X_6 = Years of poultry experience (1-5, 6-10, 11-15 and >= 16),
X_7 = Type of poultry enterprise (marketing and distribution, processing and production),
X_8 = Purpose of rearing poultry (multiple purposes and income generation),
X_9 = Average capacity per cycle (20-100, 101-500 and above 500)
X_{10} = Specific products from poultry (both live bird and egg, chicken meat and eggs).

The study utilized the Endogenous switching probit model, a two-stage analytical approach. During the first stage, the decision-making process of farmers about adaptation to climate change strategies was modelled in the ESPM. In the second stage, the model further investigates the impact of CCAS on household food security with a group of explanatory variables. However, smallholder poultry farmers that adopts CCAS were determined by their awareness of adaptation strategies and adjustment to reduction of negative consequences of climate change.

Results and Discussion

Adoption of climate change adaptation strategies and household food security of smallholder poultry farmers

The results of the endogenous switching probit model are presented in Table 1. The results obtained demonstrate that the variables of sex, age, infrastructure, and external organizations had statistically significant coefficients in terms of their influence on adopting adaptation strategies. The results reveal a statistically significant and negative impact of SPF's sex on adopting CCAS for food security. This suggests that there is a reduced probability of males implementing adaptive measures, compared to females. Male farmers exhibited a 0.426 lower likelihood of adopting adaptation strategies than their female counterparts. Smallholder female poultry farmers adopt the most effective techniques and technologies, that is, the use of medicine and vitamins that are believed to improve their productivity and ensure food security. This aligns with the study conducted by Oyenpemi et al. (2023) that posits that female cocoa farmers adopt the use of new technologies to improve their productivity.

The age of farmers had a negative effect on the adoption of CCAS. The potential reason for the impact of age could be that older farmers may exhibit a greater degree of resistance to new ideas and technological advancements. Aged farmers may exhibit a greater inclination towards risk aversion, opting to adhere to conventional methodologies they are acquainted with instead of exploring innovations. Moreover, older farmers may exhibit a reduced inclination to obtain information regarding CCAS. This aligns with the study conducted by Zakari et al. (2022). The negative impact of age on food security among the farmers who have adopted and those who have not adopted adaptation strategies plays a crucial role in elucidating the diversity in food. The negative effect of age on food security among smallholder poultry farmers could

be attributed to poorer health or physical capability among the older category. This may impede their ability to perform optimally on their farms, leading to diminished productivity and income. This would exhibit a lower propensity to embrace new technologies, potentially affecting their competitiveness in the market and hindering the sustainability of their enterprise. This is in line with the studies of Bidzakin et al. (2019) and Ojo et al. (2021).
Furthermore, farmers' infrastructure ownership was determined to have a statistically significant and negative impact on the adoption of CCAS, with a significance level of 5%. Farmers who possess infrastructure were found to be 0.237 times less inclined to adopt CCAS as opposed to their counterparts who lack the necessary infrastructure. One possible explanation for this phenomenon is a knowledge gap among farmers regarding the advantages of employing such strategies. Farmers who lack knowledge regarding the potential advantages of climate change adaptation strategies may exhibit a reduced inclination towards investing in new infrastructure or technologies like water ventilation, even though such investments could potentially aid them in adapting to the dynamic climate conditions.

Table 1 further reveals that external organizations had a negative and statistically significant effect at 5% on the adoption of CCAS. Poultry farmers who have access to external organizations were 0.168 times less likely to adopt CCAS. This denotes a lack of comprehension by external organizations regarding the unique requirements and limitations of individual farmers. Consequently, they endorse technologies that are unsuitable or impractical for the local setting. Furthermore, farmers could view external organizations as aliens and lack the confidence and affinity necessary to promote the adoption of new techniques.

Access to credit significantly negatively affects food security among SPFs who have adopted and those who have not adopted adaptation strategies. This suggests that the availability of credit may lead to an increased need for credit among farmers to fund their poultry farming activities, potentially lead to financial difficulties. The credit terms and conditions offered to farmers may not be advantageous, resulting in higher interest rates and additional restrictions that impede their financial management, farm investment capabilities, and food security. The study by Onya and Ejiba (2020), which found that credit access was an important factor influencing households' food security, lends credence to this conclusion.

The results also show that marital status had a positive and statistically significant impact of 10% on household food security among poultry farmers who have adopted and those who have not adopted adaptation strategies. The result implies that married poultry farmers would have an increase in income if they adopted an adaptation strategy. Married farmers will be saddled with the responsibility of supplying their families' food requirements and other needs. This is in line with Mulungu and Kangogo (2022), who found that marital status significantly influences the adaptability of the crop-poultry integrated system.

Results in Table 1 also indicate that livelihood significantly positively affected household food security among poultry farmers who have adopted and those who have not adopted adaptation strategies. Secure livelihoods mitigate farmers' susceptibility to the adverse impacts of climate change (Tofu and Wolka, 2023; Oyenpemi et al., 2023), including but not limited to droughts, floods, and other climate-

induced disasters. This implies that smallholder poultry farmers with stable sources of income may diversify their sources of income and allocate resources toward implementing climate-resilient technologies. The results show that education significantly and positively affects household food security among the categories of farmers who have adopted and those who have not adopted adaptation strategies. This could mean that education may have the potential to equip them with crucial knowledge and skills necessary for efficient poultry farm management. These skills may include financial management, disease prevention, and climate change adaptation strategies, among others. Education has the potential to equip farmers with the ability to recognize new technologies that can boost their productivity and increase their capacity to withstand adverse climate change. This is in line with the result obtained by Gao et al. (2019).

Smallholder poultry farmers' experience significantly positively affected food security among farmers who have adopted adaptation strategies at a 1% significant level. The correlation between farmers' food security and their level of experience may be attributed to their exposure and their comprehensive knowledge of poultry farm management, such as feed management, stocking of adaptable foundation stock, water management, and climate change adaptation techniques, enabling them to make well-informed decisions regarding the most appropriate adaptation strategies for their farms. Experienced farmers may possess extensive connections within the agricultural sector, enhancing their input acquisition and market opportunities. This result is in connection with the studies of Nwobodo et al. (2023) and Oyenpemi et al. (2023), which affirmed the positive impact of the vast experience of smallholder farmers on household food security and their contribution to the achievement of sustainable development goals.

Additionally, Table 1 shows that household size significantly positively affects food security among poultry farmers who have not adopted adaptation strategies. This indicates that there will be sufficient family labour to assist in poultry farming activities, resulting in a rise in the farmer's productivity. Members of the household make considerable contributions to the provision of family labour, resulting in a higher income. This is consistent with the findings of Ojo *et al.* (2021) and Mulungu and Kangogo (2022). Table 1 also indicates that awareness of adaptation strategies significantly negatively affects food security among farmers who have not adopted adaptation strategies. There exist potential factors that could impact the correlation between awareness of adaptive strategies and food security. These factors may include resource availability, market accessibility, and cultural influences that may affect farmer behaviour in the adoption of adaptive strategies aimed at improving their productivity and enhancing food security. Farmers' access to extension services significantly positively affects food security among SPFs who have adopted adaptation strategies and has a negative effect on those who have not adopted adaptation strategies. This implies that extension services provided effective information to support the productivity and household food security of the farmers. The result agrees with the findings of Onwuaroh et al. (2024) and Adego et al. (2019) that extension agents facilitate the dissemination of information that can improve the implementation of adaptation strategies, leading to increased poultry productivity and food security.

Table 1: Impact of adoption of CCAS on household food security.

Variables	Selection model	Food secure	Food insecurity
	Coeff. (P-value)	Coeff. (P-value)	Coeff. (P-value)
Access to credit	-0.336 (-1.620)	-1.088** (-2.250)	0.802*** (2.970)
Sex	-0.426** (-2.440)	-1.669*** (-3.430)	0.325 (1.510)
Age	-0.023** (-1.810)	-0.128*** (-3.040)	-0.031** (-1.850)
Marital status	0.049 (0.620)	0.265** (1.750)	0.476*** (3.300)
Livelihood	-0.007 (-0.070)	1.079*** (3.030)	0.273** (1.930)
Education	0.001 (0.010)	0.834*** (2.860)	0.653*** (4.330)
Experience	0.029 (1.600)	0.107*** (2.850)	-0.031 (-1.390)
Household size	-0.069 (-0.310)	0.287 (0.450)	-0.970*** (-3.240)
Infrastructure	-0.237** (-2.040)	-0.610** (-2.240)	0.309** (1.800)
Extension	0.177 (1.510)	1.535*** (3.080)	-0.334** (-2.500)
Awareness	0.365 (1.610)	0.569 (1.160)	-1.190*** (-3.910)
Cooperative	-0.041 (-0.420)	-0.067 (-0.360)	0.276 (2.350)
External organization	-0.168** (-2.290)		
_cons	2.350 (2.350)	(0.460)	-1.680 (-1.860)
/athrho1	15.702 (3.26)		
/athrho0	-4.169 (2.576)		
rho1	1 (0.0023)		
Wald chi2 (12)		31.31***	
Log-likelihood		-326.44	

*Significance levels: **: 5% ***: 1%*

Estimated Impact of Climate Change Adaptation Strategies on Food Security

Table 2 shows that the estimated ATE for the adoption of adaptation strategies on food security was 1.923, statistically significant at 1%. This suggests that, on average, poultry farmers in the study area could increase their food security by 1.923 if they adopt CCAS. The conditional treatment effects indicate an ATT of 1.434, which was also statistically significant at 1%. Hence, the average smallholder poultry farmer in the adopter group would have 1.556 times more food security than if they did not adopt CCAS.

Aligned with the switching probit regression, AIPW demonstrates notable improvements in enhancing food security through the adoption of adaptation techniques. In Table 2, ATE and ATT stand at 1.556 and 4.708, respectively. This implies that the food security of sampled farmers benefiting from CCAS adoption would be 1.556 times higher than the average if none had adopted CCAS. Similarly, the adopter-treated group experiences a gain of 4.708 compared to what they would have without CCAS adoption. Both estimation techniques underscore that strategies mitigating climate change's adverse effects significantly boost poultry farmers' food security. This positive impact aligns with the findings of Mulungu and Kangogo (2022), who identified a substantial impact on food security through the adoption of an integrated crop-poultry system.

Table 2: Treatment effects of the adoption of CCAS on food security

Endogenous switching regression model	***Coefficient***	***Std.***
Average treatment effect (ATE)	1.923***	0.515
Average treatment on the treated (ATT)	1.434***	0.045
Augmented-Inverse -probability-weighted *(AIPW)*		
Average treatment effect (ATE)	1.556***	0.004
Average treatment on the treated (ATT)	4.708***	0.003

*** P≤0.01

Conclusion and Recommendation

Sex, age, infrastructure, and external organizations significantly influenced smallholder poultry farmers' decisions to adopt climate change adaptation strategies. These adaptation strategies have a significant impact on the food security of smallholder poultry farmers. Therefore, it is advised that policies be put in place to help smallholder poultry farmers make better choices regarding the use of strategies for adapting to climate change. Also, provision of climate change adaptation strategies should be included in government policies and investment plans for improved livelihoods and increased food security.

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