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Climate Change Adaptation among Poultry Farmers: Evidence from Nigeria

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Introduction

We explore the level and determinants of the adoption of climate change adaptation strategies among poultry farmers in Nigeria. Poultry, a source of protein and income for many households in Nigeria, plays an important role in food security. Despite its importance for livelihoods in the country, there is limited information about how the Nigerian poultry subsector is affected by climate change. This is one of the first studies to study this issue in the Nigerian context. We use primary data from a sample of small, medium and large poultry farmers to 1) explore differences in the adoption of and types of practices employed by poultry farmers at different production scales and 2) the drivers of the adoption of multiple strategies. The results draw on descriptive statistics and regression analyses using a multivariate probit, poisson and fractional response probit estimation approaches.

Data

This study relies on a poultry farmers' survey conducted in Kaduna and Oyo states in Nigeria between August and September 2017. Within each local government area (LGA), households were categorized into four groups according to the number of birds held: zero to five birds, six to 30 birds, 30 to 100 birds, and more than 100 birds. The final sample for the household farms consists of a random selection of 150 households from each of the four categories. For non-household farms/commercial farms, all the farms identified in the 11 (4) LGAs in Ibadan (Kaduna) were listed and subsequently included in the sample. Given that there were non-responses, the analysis in this paper includes 1,301 poultry farms across 11 LGAs in both states; 677 farmers in Oyo state and 624 in Kaduna state. The survey gathered socio-demographic information on poultry farmers and the characteristics of their farms including management and marketing practices. We also collected information on farmers' perceptions of climate change and their adaptation strategies in response to an increase in the length of heat stress now compared to 20-30 years ago. Throughout this process, we interacted extensively with various actors along the poultry value chain in Nigeria including poultry farmers, veterinary doctors, animal scientists, researchers and poultry input dealers.

Key Findings

- The poultry sub-sector in Nigeria is experiencing rapid growth and transformation.
- However, heat stress associated with climate change is a challenge to poultry farmers due to its negative effect on chicken growth and productivity
- Small poultry farmers tend to invest in traditional strategies such as stocking local breeds
- Medium and large poultry farmers adopt modern technologies such as air and water ventilation and bulbs that emit less heat
- Farmers who have experienced heat related losses are more likely to adopt modern practices (water ventilation, pay for litter spreading, buy medicines and vitamins or use energy efficient bulb) and more likely to adopt multiple adaptation strategies.

Table 1 shows that about 68% of poultry farmers in our sample believe that the temperature has increased significantly. Almost 50% of all poultry farmers reported that they had observed an increase in the length of heat stress in their state. In addition, 10% of all farmers have experienced losses of product (chicken, eggs) due to weather events such as heat wave. Consequently, we consider a set of eight adaptation strategies that poultry farmers are recommended to use in response to heat stress in the estimations. These strategies include air ventilation, water ventilation, engagement in fish farming, litter spreading and de-caking in chicken houses, the use of energy efficient bulbs, the use of vitamins and medicines for the birds. These strategies are relatively novel in the context of the study because they have emerged as a practice in recent years. Additionally, we incorporate

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traditional practices which we define to include early stocking of birds, higher frequency of litter change during the heat period, and keeping local breeds of birds.

Table 1. Climate adaptation strategies and farmers' perceptions

	All	T1[a]	T2	T3
	Mean			
Experienced loss from weather event (0/1)	0.100	0.100	0.180	0.190
Use Air ventilation (0/1)	0.045	0.042	0.062	0.163
Use Water ventilation (0/1)	0.003	0.000	0.016	0.147
Pays for litter spreading or decaking or clean out (0/1)	0.062	0.044	0.367	0.487
Use Traditional practices (0/1)	0.708	0.723	0.390	0.411
Buy medicines (0/1)	0.127	0.102	0.543	0.752
Buys vitamins (0/1)	0.292	0.277	0.507	0.723
Have a fish farm (0/1)	0.009	0.004	0.089	0.153
Use Energy efficient bulb (0/1)	0.078	0.070	0.160	0.334
Average temperature increased (0/1)	0.682	0.701	0.323	0.292
Length of heat stress is longer (0/1)	0.451	0.460	0.250	0.297
N	1301	449	428	424

Note: [a] T1, T2 and T3 refer to farm size (bird holding) terciles where T1= 0-100 birds, T2=101-1,000 birds and T3=>1,000 birds. The values have been weighted to be representative of the study regions.

Overview of the adoption of adaptation strategies

Adoption of various adaptation strategies in Nigeria varies significantly across farms of different sizes (Table 1). While about 12% f medium (T2) and large farms (T2) have both poultry and fish farms on the same premise, only 0.1% of small farms reported the same. For water ventilation as well, adoption rates by the smallest farmers is less than 1%. While 15% of large farms adopt water ventilation practices, only about 2% of medium farms adopt this practice. This reflects differences in the strategies that are being adopted across farm sizes. Though the adoption of air ventilation practices is generally higher than water ventilation, adoption is largely restricted to larger farms. 16% of large farms use air ventilation alongside 6% of medium farms. The adoption rate for energy efficient bulbs is relatively higher than air and water ventilation but varies across farm type. It is also largely adopted by larger farms, at more than 30%, compared to 16% for medium farms, and only 7% for small farms. Investments in medicines and vitamins increase with farm size but many more farmers buy vitamins. Overall close to 30% of farmers buy vitamins for their birds but this is driven by medium and large farms. The same holds true for medicines. Though 13% of farms buy some it is not uniform across farm types: 10% of small farms, 54% of medium and 75% of large.

Overall about 70% of all farms implement traditional strategies practices (early stocking, frequency of litter change and/or keeping local breeds). However, the number of farms which adopt them decreases as the size of the farm increases. In effect, 72% of small farms revert to these practices but only 40% of medium and large farms do the same. A look at each of the strategies that make up the traditional strategies present a similar picture. The practice of early stocking, though more popular among medium and large farms, is still only practiced by about 5% of medium and large farms. The use of litter spreading or de-caking of the chicken houses also varies significantly across farm types. Among the practices where we do see significant participation of small poultry farmers is frequent change in litter and the use of local breeds. For the frequency of litter change, this is 60% of small farms compared to only about a third of medium and large farms (30-35%). Changing the litter is considered a labor-intensive practice and this might reflect the willingness of small farms to adopt adaptation strategies that might be more labor intensive but less costly. As for keeping local birds, it is practiced by 65% of small farm, 16% of medium farms but only 4% of large farms. Interaction with small farms revealed that they prefer local breeds because they are low maintenance and can sustain heat stresses better than imported breeds.

Effect of heat related losses on the adoption of adaptation strategies

The analysis on the determinants of the adoption of adaptation strategies using multivariable probit regressions show that farmers who have experienced climate related losses are more likely to adopt water ventilation, pay for litter spreading, buy medicines and vitamins or use energy efficient bulbs. On the other hand, exposure to extreme heat discourages investment in a fish farm. This indicates that farms are less likely to invest in building a fish farm on the poultry farm if they have incurred losses in the past. Experiencing loss due to extreme heat does not influence the adoption of air ventilation and traditional practices. As one would expect, the direction of the effect is negative for the former while it is positive for the latter. The correlation matrix from the multivariate probit shows positive and statistically significant correlations between the use of air ventilation, water ventilation, litter spreading, and energy efficient bulbs, suggesting that these modern adaptation practices complement each other. These four adaptation practices are, however, negatively correlated with the use of traditional practices, indicating possible trade-offs between modern and traditional adaptation practices.

A look at the determinants of the adoption of multiple adaptation strategies using poisson and fractional probit response (FPR) models show that, on average, farmers who have personal experience of loss due to extreme heat are more likely to adopt multiple adaptation strategies. Compared to those who did not experience heat related losses, those who experienced it are 66.3% more likely to adopt multiple strategies. Additionally, those who suffered climate induced losses are 9% more likely to adopt a larger share or percentage of the studied adaptation strategies.

Policy implications

The findings have important implications for policy makers and practitioners including poultry farmers and extension agents. The fact that the adoption of modern strategies appears limited to medium and large scale farms requires further attention. There is room for innovation as some of the costly strategies such as ventilation adopted by the larger farms can be modified to suit the financial constraints of the small farms. For example, changing water more frequently to keep water cool compared to having a cooling pad or fan. Such strategies should be developed and communicated to farmers. Where modern strategies are inappropriate due to farm size, efforts to breed faster growing more adaptable breeds (as it relates to the tolerance of heat stress) could be helpful.

Key references

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The decision to adopt a specific adaption strategy depends on an unobservable latent variable (farmer's utility), which is determined by one or more explanatory variables such as their experience with poultry farming, their knowledge about the practices, their scale of operation etc. The higher the utility, the greater the probability of adoption. Although we do not observe the latent variable $\boldsymbol{Y_{im}^*}$ for each strategy m that farmer i can adopt, we can quantify the ultimate decision in terms of the farmer adopting or not adopting with a variable $\boldsymbol{Y_{im}}$. This is a binary decision which can be estimated using a probit model where the response probability depends on a set of parameters which are a function of the standard normal cumulative distribution. In our study we are considering 8 different strategies. Thus we model the farmer's adoption decision using the following 8 equation multivariate probit model in line with Cappellari and Jenkins (2003)

$$\boldsymbol{Y_{im}^{*}} = [\boldsymbol{X_{im}'\beta_m} + \boldsymbol{\varepsilon_{im}}]; \boldsymbol{m} = \mathbf{1}, \mathbf{2}, \dots, \mathbf{8}$$

$\boldsymbol{Y_{im}}$= 1 if $\boldsymbol{Y_{im}^{*}} > 0$ and 0 otherwise, $\boldsymbol{\varepsilon_{im}}$, m = 1, …, 8, are error terms distributed as multivariate normal, each with a mean of zero, and variance-covariance matrix V, where V has values of 1 on the leading diagonal and correlations $\rho_{jk} = \rho_{kj}$ as off-diagonal elements.

$\boldsymbol{X_{im}}$ is the vector of explanatory variables included in the model. $\boldsymbol{\beta_m}$ is a vector of parameters to be estimated. We evaluate the multivariate probit model using Geweke-Hajivassiliou-Keane (GHK) smooth recursive conditioning simulator. For each observation, a likelihood contribution is calculated for each replication, and the simulated likelihood contribution is the average of the values derived from all the replications. The simulated likelihood function for the sample as a whole is then maximized using maximum likelihood.

Next, we model the extent of adoption of the adaptation strategies. Here we define a new outcome variable equal to the number of strategies adopted by farmer i. The outcome variable now is a count variable which takes on the following nonnegative integer values: {0, 1, 2, 3, 4, 5, 6, 7, 8} We estimate the model using the poisson estimation strategy The underlying poisson distribution has the advantage of only being determined by its mean (Wooldridge 2010). The probability that the outcome variable y equals the number of adaptation strategies adopted can be modelled as follows:

$$P(y|\boldsymbol{x}) = \exp[-\mu(\boldsymbol{x})]\,[\mu(\boldsymbol{x})]^{y}/y!;\; y = 0, 1,2,3,4,5,6,7,8$$

where $y!$ is y factorial, $\mu(\boldsymbol{x}) = \exp(\boldsymbol{x\beta})$, and $\boldsymbol{x}$ is a vector of explanatory variables include in the model. $\boldsymbol{\beta}$ is a vector of parameters to be estimated.

To confirm that our results are not driven by the selection of the estimation strategy, we also express the extent of adoption as the share of the total number of strategies that a farmer adopts. The outcome variable (y) here is the number of strategies adopted out of a total of eight strategies. We use a fractional probit model and model the conditional mean as a probit function:

$$E(y|\boldsymbol{x}) = \Phi(\boldsymbol{x\beta})$$

where Φ is the normal distribution and $\boldsymbol{x}$ is a vector of explanatory variables include in the model. $\boldsymbol{\beta}$ is a vector of parameters to be estimated.

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