RISKS SOURCES AND MITIGATION STRATEGIES IN POULTRY (EGG) PRODUCTION IN THE AGRARIAN COMMUNITIES OF LAGOS STATE, NIGERIA

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ARTICLE INFO	ABSTRACT
	Poultry farming provides rich source of animal protein and contributes significantly to food security among Nigeria households. However, the poultry sector is largely vulnerable to risk conditions, ranging from natural events, climate disturbances, and human lapses resulting in tumultuous performances of the poultry enterprise. This study was carried out in the agrarian suburb of Lagos State, Nigeria to determine the dominant risk sources in the poultry egg sector, and the determinants of mitigation strategy adoption among egg farmers. Primary data were obtained in a cross-sectional survey of 125 poultry egg farmers drawn by multi-stage random sampling across major communities in the study area, and were analysed by both descriptive and quantitative techniques. A risk behavioural model (RBM) was used to estimate the determinants of farmers' adoption of specific mitigation strategies. From the findings, 62% of the respondents were male, married (64%), formally educated (74%), and of mean age and household size 40 ± 15 years and 4 ± 2 persons, respectively. Average farmer's flock size was 524 ± 327 layers, 6 ± 5 average years of farming experience, and average gross income of ₦1,490,000/production cycle. The identified risk factors (response scores and survival propensities in parentheses) were; disease epidemic shocks (1.82, 44.67%); egg glut shocks (1.85, 39%); adverse weather shocks (2.01, 53%); and input price instability shocks (2.21, 60%). Identified lead risk mitigation strategies were strict adherence to routine vaccination regime; advance egg sales arrangement; proper timing/frequency of bird stocking, and advance/wholesale inputs purchase arrangements. Findings from the study established that medically disenfranchised (2.974; p<0.01) and non-remotely located farms (1.682 p<0.1) had higher propensity for routine vaccination/drugs administration to mitigate disease outbreak. Likewise, experienced farmers (2.780; p<0.01) operating farms with less capital-based assets (2.655; p<0.01) would more likely adopt advance sales arrangement to mitigate egg glut shock. With better human skills development (2.173; p<0.05), poultry farmers would likely engage proper timing for birds stocking to mitigate the effect of adverse weather condition on their farms. To enhance farmers' timely access to major inputs (feeds, drugs and stocks) for a sustainable poultry egg industry in the study area, localisation of farms within policy-regulated areas and proximity to input supply firms were recommended.

1.   INTRODUCTION

Poultry production contributes about 15 percent of the total annual protein intake with approximately 1.3kg of poultry products consumed per head per annum (Oladeebo and Ambe-Lamidi, 2007) in the Nigerian agricultural sector. Poultry serves as a good source of animal protein, and contributes significantly to food security and poverty alleviation in Nigeria (Nasiru et al., 2012); with the demand for its two major products (egg meat chicken meat) projected to rise by 200% between 2010 and 2020 (USDA, 2013 and Heise et al., 2015). This underscores the earlier position of Tadelle and Ogle (2001) that the poultry sub-sector occupies a unique position in the Nigerian gross domestic products (GDP)'s accounting in terms of high quality protein contribution to rural farm families in Africa, besides its economic and social values. In specific terms, the poultry industry contributes enormously to the Nigerian economy, providing job opportunities for the inhabitants, and a major income source to the inhabitants of rural and semi-urban communities. About 70% of the world's rural poor depends on agricultural production as major components of their livelihood (FAO, 2006), with the poultry sector claiming over 50% of the total livestock population as far back as 2010 in the Nigerian scenario, showcasing it as particularly prominent among other livestock sub-sectors (Nasiru et al., 2012).

Despite this, the activities of poultry egg farmers are characterized by low productivity, high input costs, low-quality/disease resistant chicks (stocks), as well as high level of risk, which in turn reduce the relative credit capacity and accessibility to insurance facilities in comparison with other more stable livestock sub-sectors (Oparinde, 2008; Banjoko et al., 2014; Baruwa and Adesuyi, 2018). Specifically, most poultry egg farmers in developing, agrarian economies are vulnerable to income risks and situations of uncertainties which often results in tumultuous performance in egg production cycles (World Bank, 2005; WOAH, 2013a&b). In recent years, price volatility has increased with sharp swings in product and input prices. The Nigerian poultry sub-sector is adversely bedeviled by various problems associated with the raising of stocks, such as disease susceptibility and sensitivity of the livestock to nutrient deficiencies and adverse environmental factors including temperature, ventilation, light and sound (Adebayo and Adeola, 2005), reiterating the posture that the industry had continued to fall short of its objective of self-sufficiency in animal protein production (Ojo, 2003). Other serious challenges facing the poultry sub-sector include a sustained rise in the price of feed, disease outbreak, floods, fire outbreak, as well as inadequate credit facilities in the face of the global financial crisis worsened by the incidence of the covid-19 pandemic. These factors bring about uncertainty in poultry production, thus affecting the supply of poultry product in the markets.

1.1   Background of the Study

Poultry egg production like all other economic engagements is dependent on resource inputs. According to Etim and Udoh (2007), success of the poultry sub-sector depends largely on environment factors, technical know-how and the quality of resources employed in the production process. In order to optimize production and ensure sustainability, there is need for judicious management of the resources employed in the poultry egg enterprise. A growing percentage of poultry farmers in Nigeria are less equipped to cope with the attendant risks associated with poultry production, which could lead to eventual collapse of the industry if conscious and intensive efforts are not made to salvage the menace by all stakeholders. Risk in this context, is defined as "effect of uncertainty on objectives", which focuses on the effect of incomplete knowledge of events or circumstances on an organization's decision making. It is the influence of an undesirable event resulting from natural occurrences or as a result of human actions or inactions (Legesse and Drake, 2005). Risks arises from the background of asymmetric or incomplete information upon which accurate prediction of the direction of production variables could be based, such as input and outputs prices, climatic factors, and policies of government (Nyikal and Kosura, 2005). Risk therefore, has become an inherent feature in the livestock sector, constituting itself a major concern especially among poultry farmers in Nigeria where the problem of increasing prices of feed/feed ingredients, virulent diseases; unstable prices of egg amidst incessant gluts; inadequate credit supply; and low level of production specialization exist, among other production constraints (FAO, 2006).

Risk sources in livestock farming is multifaceted, and can generally be classified as production (climate factors, diseases and pests); marketing (input/output prices and production costs); financial risk (loan and its associated costs); institutional/political (changes in policies); natural (ailment/illness, deaths) as well as human (actions, inactions or negligence) according to Kahan (2013) as modified. These various risk sources require different mitigation approaches for effective management, ranging from indigenous to conventional which adopted strategies may even vary among different farmers and by geographical and farm locations (Ullah et al., 2016). Risk assessment in poultry egg production systems therefore, involves a systematic evaluation of the potential risks associated within the sub-sector, especially given the paucity of previous researches in this important aspect of poultry enterprise management in Nigeria. In other words, it involves identifying, analyzing, and evaluating risks first in order to best determine the mitigation required. Risk assessment in agriculture is thus an essential tool for farmers to anticipate, avoid and react to shocks. Risk analysis involves the process of defining the dangers to individuals, business and government agencies posed by potential natural and human-related adverse events. An efficient risk assessment system for agriculture will preserve the standard of living of those who depend on poultry egg farming, strengthen the viability of farm businesses, and provide an environment which supports investment in the farming sector. The study is justified in that the risk situations confronting the poultry egg farmers in the study area were being revealed and appropriate mitigation strategy(s) to each risk source had been

empirically verified, thus reducing the economic effects of incomplete information on the operations of the poultry enterprises. This implies the adoption of more effective and more economic operational strategies by the farmers.

1.2 Research objectives

This research is based on the following specific objectives:

- TO identify the major risk sources in poultry egg farming in the agrarian communities of Lagos State.
- TO identify the risk mitigation strategies adopted against each risk category.
- TO determine the factors influencing the adoption of specific mitigation strategies for reducing the attendant effects of observed risks in poultry egg production in the study area.

1.3 Research questions

The following questions were asked to address the main focus and objectives of the research study:

- What is the major sources of risk in poultry egg farming in the agrarian communities of Lagos State?
- What strategies are adopted by the poultry egg farmers to mitigation each identified risk category?
- What factors influence the adoption of specific mitigation strategies for reducing the effects of risks in poultry egg production in the study area?

1.4 Statement of the problem

The prolonged shocks occasioned by risk-pulled adverse effects often reduce egg production and protein intake and by extension, malnutrition and ill-health; reduces productivity and output level; and consequently, poor livelihood status among the egg farmers (Bamiro *et al.*, 2009). This situation therefore justifies the need for a proper assessment of the risk situation in poultry egg production systems in the agrarian communities of Lagos State, Nigeria.

2. REVIEW OF LITERATURE AND THEORETICAL FRAMEWORK

2.1 Risk concept and measurement

Risk definition and its measurement is still an open issue for discussion in scientific literature. Many disciplines dealing with risk have different views about it and the components to be included in the process of its determination. Therefore, there are substantial discrepancies in risk literature, reflecting different disciplinary views of the subject. Generally, risk is defined as "the combination of the probability of an event and its negative consequences" (UNISDR, 2009). It is usually associated with the degree to which humans lacks the coping capacity for a particular situation (e.g. natural hazard).

2.2 Theoretical framework

- Disaster risk can be determined by the presence of three variables: hazards; vulnerability to a hazard; and coping capacity linked to the mitigation, reduction, or resilience to the vulnerability of an enterprise (poultry farming in this case) associated with the specific hazard being considered. Therefore, disaster risk (R) is conceptualised as the expected damage, which is calculated as a function of these three pillars of hazard (H), vulnerability (V), and coping capacity (C), where the outcome of these three affects the former (Crichton, 1999). Thus,

$$R = f(H, V, C) \qquad \text{(i)}$$

or specifically, $\quad R = \dfrac{H x V}{C} \qquad \text{(ii)}$

Hazard is a dangerous phenomenon, human activity or condition that may cause death of livestock, injury or other health impacts, asset damage, or environmental damage" (UNISDR, 2009). *Vulnerability* is the characteristics and circumstances of an enterprise that make it susceptible to the damaging effects of a hazard. It is a set of prevailing or consequential conditions resulting from the combination of physical, environmental and social components factors which increase the susceptibility of an enterprise to the impact of hazards (UNISDR, 2002). *Coping capacity* for disaster risk reduction refers to the ability of an enterprise to endure or survive adverse conditions such as hazards, emergencies or disasters. Coping capacities contribute to the reduction of disaster risks (UNISDR, 2009).

- Disease epidemics and weather-related hazards for instance, are common natural disasters risks in the poultry enterprise. The term disaster risk refers to the potential (not actual or observed) disaster losses, in livestock (layers') health status, livestock products (e.g. egg), or farm assets, etc that may occur in a particular poultry enterprise. Disaster risk therefore, is the product of the possible damage caused by a hazard as a result of its vulnerability within a poultry farm. It is worthy of note, that the effect of a hazard (of a particular nature or magnitude) would affect poultry enterprises differently as a result of the coping strategy adopted from one farm enterprise to another. Less experienced farmers and less capitalised farms are therefore more at risk than those that have continuously been in operation for a couple of years with better capital base and expertise capacity to cope with identified risks.

- The foregoing was modified and adapted to the conceptual theory developed for this study. In this framework, either one of risk reduction approach (RRA) or risk adaptation approach (RAA) is often adopted to combat an observed risk situation. Following from the left hand side of the model, risk shocks often emanate from nature or as a

result of human actions or inactions (Nyikal and Kosura, 2005) thereby threatening a poultry enterprise mainly from the production (e.g. disease, input shortages, mortality, etc) and (or) marketing side (e.g. eggs breakages in transient, egg gluts, among others). These are mainly physical losses that eventually translate to direct financial losses to the farmer. Evaluation of a production system to establish the extent of its risk vulnerability or risk potentials entails proper analyses to detect gaps or operational loopholes that could be hacked upon by potential threats to disparage the system and cause efficiency reduction (in physical, qualitative or monetary units). This is usually achieved through the instrumentality of vulnerability assessment. Where threats are detected, they are responded to via calculated actions or set of activities which normally may be integral parts of, or external to the system, the outcome of which is expected to be a partial or total revamping of the system efficiency (usually termed risk survival), which 'absolute' or 'relative' outcome can be determined or measured.

Fig. 1. Conceptual framework of the risk attitude of poultry egg farmers
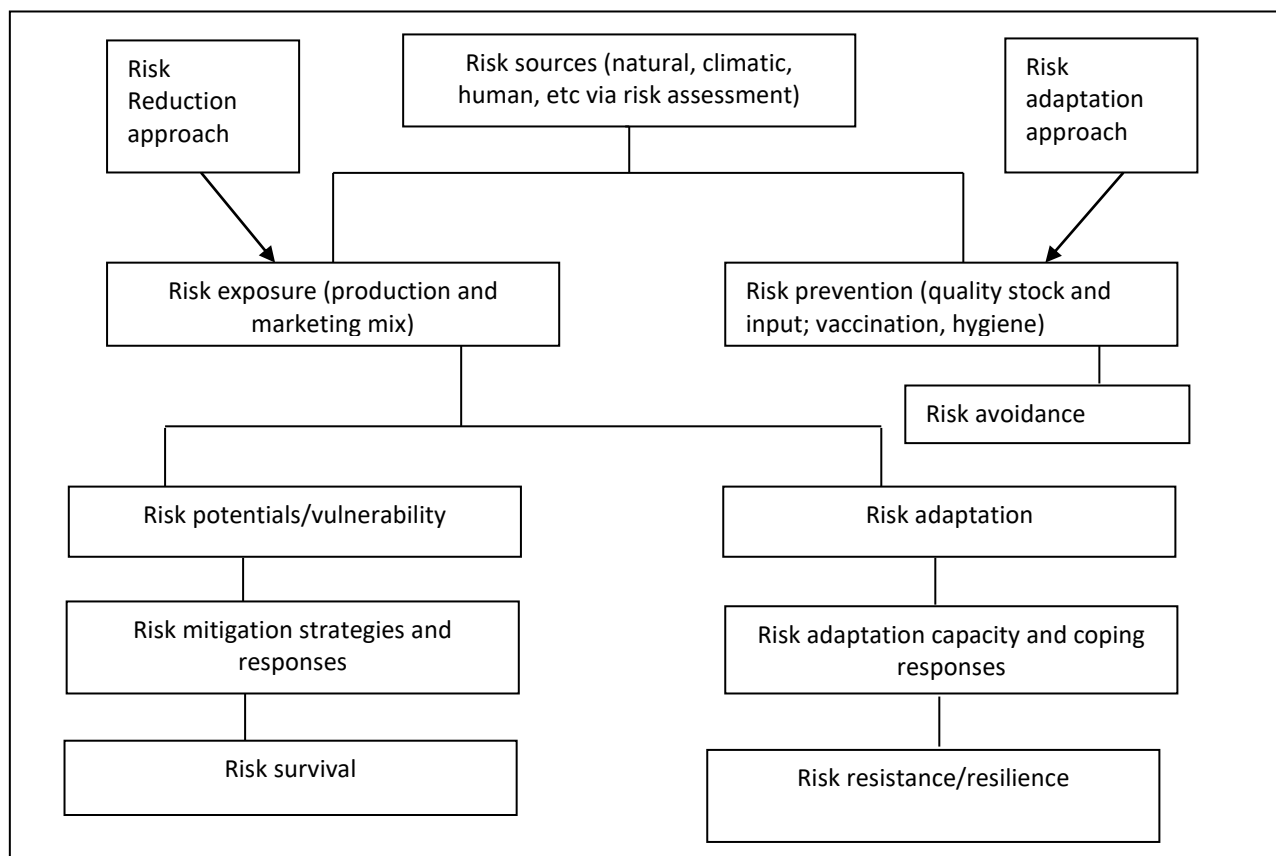
Source: *Adapted from Crichton, 1999; Martina, 2012*

•   On the right hand side of the framework, the risk adaptation approach to risk assessment is conceptually highlighted. Almost all exposure to natural hazards and vulnerability can be controlled, mitigated or reduced in terms of its outcome consequences. With sound management practices in place in poultry egg enterprises (such as stocking time, vaccination programme planning), almost all "natural disasters" associated with poultry egg farming could effectively be mitigated. On the other hand, human actions such as negligence, delayed actions and human errors in decision making can easily aggravate the consequential effects of these natural hazards. In practical terms therefore, the reduction/mitigation of a risk situation from manifesting in a disaster therefore requires a broad concerted activities and efforts of all stakeholders (such as agricultural extension agent, agricultural service providers, input sellers, and egg/livestock products buyers) to ensure that natural hazards do not degenerate into becoming disasters. Cross-breeding in poultry farming for instance, is a form of coping strategy through the adaptation process, which often comprises both indigenous and conventional (exotic) selection of breeder stocks to arrive at outcomes with greater adaptive capacity and resistance/resilience to risk situations.

3. RESEARCH METHODOLOGY

The study area was Lagos State, being the smallest but most economically viable of all the 36 states in Nigeria, situated within the South-Western zone, well known for its high concentration of commercial poultry (Adedeji et al., 2013; Omodele and Okere, 2014). Lagos State composes the nation's largest and widely spread urban cities with pockets of adjoining communities where a number of agricultural activities (especially poultry production) take place, including

Ikorodu, Epe and Badagry (Bamiro, et al, 2013; Omolajo, 2018). On the northern and eastern axes of Lagos State lie a sizeable number of agrarian communities that share borders with Ogun State, which directly benefits from the economic overflow of the study area. On the West, Lagos State shares boundaries with the Republic of Benin, and behind its Southern borders lies the Atlantic Ocean, with lagoons and creeks claiming about 22% of its 3,577km^2 land space.

A three stage sampling procedure was adopted in selecting poultry (egg) farmers for this study. One hundred and twenty-five (125) poultry (egg) farmers whose farms have been in operation for a minimum of five (5) years, and whose egg laying enterprise had observed at least three (3) years of consecutive laying cycles had their data included in the analysis. The list of poultry farmers in the Lagos State (and their locations) were obtained from the State's Ministry of Agriculture and Cooperatives, Ikeja. The first and second stages of selection involved a purposive inclusion of the agricultural suburb regions (Ikorodu, Epe and Badagry) of the State, and only established poultry (egg) enterprises located within these regions respectively, from the list of poultry farmers obtained. By this selection, non-egg producing poultry enterprises and relatively newer farms were excluded from the sample frame. The third stage selection of sampled poultry (egg) farmers was done proportionate to the size of poultry farm operators in each of the regions, resulting in the final selection of 54 (Ikorodu), 30 (Epe), and 41 (Badagry) farms, respectively. This sampling proportionate to the size procedure followed the approach adopted in previous studies carried out in Lagos State (e.g. Evbuomwan, 2005; Apantaku, 2006; Bamiro, et al, 2013; and Omolayo, 2018) due to the concentration of poultry enterprises mainly in the sururb and peri-urban regions of the State.

Structured questionnaires were administered to obtain primary data from the sampled poultry egg farmers, while relevant guiding information were sourced from published documents of the Poultry Association of Nigeria (Lagos State Chapter), and other official publications from the National Bureau of Statistics (NBS).

4. DATA ANALYSIS

4.1 Risk survival propensity rating and the index of farmer's risk mitigation strategy in poultry egg production

Each poultry egg farmer was presented with a list of risk mitigation strategy option within each of the four risk categories (see Appendix I) to indicate their level (or frequency) of adoption within one egg production cycle. The extent of adoption of a mitigation strategy was calibrated on a likert scale of value intervals 0-4 at a relative strategy adoption frequency (P_i) rated between 0 and 100%, as:

0 = if farmer never adopts the i*th* specific coping strategy, $P_i = 0\%$
1 = if farmer adopts the i*th* specific coping strategy at $P_i < 30\%$
2 = if farmer adopts the i*th* specific coping strategy at $30 < P_i < 50\%$
3 = if farmer adopts the i*th* specific coping strategy at $50 < P_i < 70\%$
4 = if farmer adopts the i*th* specific coping strategy at $P_i > 70\%$

Based on the above, a mean (average) risk mitigation response score (MRS) was computed for each risk category by multiplying the index of risk mitigation strategy (*RMS*; captured in equation iv), by the number of available mitigation strategy option in each risk category, *k*. The risk occurrence frequency (ROF) is the arithmetic summation of the tendency of risk occurrence (for high and low risk frequency only) in the specific risk category, while the relative risk occurrence frequency, or factor, (rROF) is obtained by dividing each ROF value by the total risk occurrence frequency (Total ROF) value.

The percentage risk survival propensity (RSP) value is a measure of the probability of a farmer surviving a risk situation, given the administration of a mitigation strategy. It is estimated as:

$$RSP = rROF \times MRS \text{ (\%)} \qquad\qquad (iii)$$

where:
RSP = Risk survival propensity (%)
rROF = relative risk occurrence factor (in the specific risk category), and;
MRS = mean (or average) risk mitigation response score

A risk mitigation strategy (*RMS*) index was constructed to determine a farmer's choice of risk mitigation strategy [1] option for each of the four self-reported risk categories of the poultry farmers (namely, Y_1, Y_2, Y_3, and Y_4), following Ologbon et al. (2013), thus:

$$RMS_i = \frac{\sum_{1=i}^{j} C_i P_i}{4k} \qquad\qquad (iv)$$

where:

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[1] See Appendix A for the classification of risk mitigation strategy options

RMS = risk mitigation strategy index

C_i = choice of the i*th* specific mitigation strategy in the *j*th risk category (1 if the poultry farmer adopts the specific coping strategy; and 0 if otherwise)

P_i = relative frequency of adopting the i*th* specific mitigation strategy in the *j*th risk category. This takes on values from 0-100%.

k = number of available mitigation strategy options in the *j*th risk category (j = 4).

4.2 Risk mitigation modeling and its estimation procedures

The study data were analysed using descriptive and inferential statistics. Specifically, relevant risk behavioral models (RBM) were fitted to the surveyed data set. The RBM model captured the influence of selected farmer's socio-economic and farm-level factors on the different mitigation strategies adopted by the surveyed farmers to cope with each of the reported risk categories. Following the studies of Adepoju *et al.* (2013) and Babalola (2014), the implicit form of the RBM regression model fitted to the data is given as:

$$Y_i = f(S_i, ..X_{i...}, Z_i, ..., u_i) \tag{v}$$

where the [2]dependent variable, Y_i is the probability of the *i*th respondent adopting the risk mitigation strategy (*RMS*) with the highest index value in the risk category.

Y_1 = [a]*RMS* adopted in the disease epidemics risk category;

Y_2 = [b]*RMS* adopted in the egg glut risk category; and,

Y_3 = [c]*RMS* adopted in the adverse weather (condition) risk category

Y_4 = [d]*RMS* adopted in the input price instability risk category

Let Y_i be the *i*th farmer's adoption of risk mitigation strategy option and $Y_i^* \, (-\infty < Y_i^* < +\infty)$ be the underlying latent variable representing *i*th farmer's probability of adopting the index mitigation strategy option. Let S_i be a vector of farmer *i*'s socio-economic characteristics relevant in explaining the risk response behavior; X_i a vector of farm-level factors; and Z_i a vector of farmer's risk attitude. The risk behavior model is based on the assumption that Y_i^* depends linearly on S_i, X_i and Z_i, according to:

$$Y_i^* = \alpha S_i^{'} + \gamma X^{'} + \omega Z_i^{'} + u_i \tag{vi}$$

α, γ, and ω are vectors of parameters to be estimated; none of them contains an intercept. u_i is a stochastic noise random variable with zero mean and variance σ_u^2. The risk behavioural regression models were fitted separately for each of the four risk categories, with a set of explanatory variables hypothesized to influence the choice of specific mitigation strategy option, leveraging upon the strong connective potentials between farm-level factors and farmers' demographic and risk-response characteristics as already postulated by the Organization for Economic Cooperation and Development (OECD) (2011) at achieving effective agricultural risk management. The hypothesized variables were categorized thus:

Farmer's demographic factors

S_1 = sex of the poultry farmer (years)

S_2 = household size (number)

S_3 = educational level (years)

S_4 = years of poultry farming experience

Farm-level/production factors

X_5 = worth of non-capital assets (stock of birds and intermediate inputs) valued in USD ($). This is taken as a proxy for the magnitude of the [3]background risk for the *i*th farmer.

X_6 = flock size (number of birds)

X_7 = distance (in kilometer) of farm to source of Medication (drugs/vaccines sales outlets) and healthcare services (veterinary doctor)

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[2] The risk mitigation strategy option with the highest index value in the *j*th risk category [a,b,c,d] (Appendix I) is accorded the underlying latent behavior of Y_i^* in the RBM

[3] Risk that cannot be avoided or 'wished away' for the farmer to remain in active egg-laying poultry business. It depicts how vulnerable the farm enterprise is in terms of the spread of stocked birds by age proportion, breed and source, as well as the availability of feeds and drugs/vaccines by types and quantity for a healthy birds' living condition.

X_8 = Accessibility to farm location (1 = if the farm is relatively accessible to wholesale egg buyers within economic range of bearable costs; and 0 if otherwise)

Farmer's self-reported risk attitude
Z_9 = farmer is risk neutral (Yes = 1; 0 otherwise)

Z_{10} = farmer is risk averse (Yes = 1; 0 otherwise)
\Z_{11} = farmer is risk preferred (Yes = 1; 0 otherwise)
u_i = error term.

5. RESULTS AND DISCUSSIONS

5.1 Demographic and farm-level characteristics of the respondent poultry farmers

Knowledge is a precursor to conscious (and perhaps, plausible) action. Therefore, analyzing respondents' socio-economic background could play a major role in explaining farmers' risk attitude and response ability in the poultry industry. The vital information underlying the likely relationship between the socio-economic endowment of the poultry egg farmers and their risk coping/mitigation strategies is the basis for the descriptive statistics presented in Table 1.

Table 1. Distribution of poultry farmers by selected demographic factors (n = 125)

Variable	*Value*	*Frequency*	*Percentage*	Cumulative	
				Frequency	**Percentage**
Gender	Male	77	61.6	77	61.6
	Female	48	38.4	125	100.0
Age	< 30	37	29.6	37	29.6
(Mean = 39.38;	31 – 40	28	22.4	65	52.0
SD = 14.70)	41 – 50	28	22.4	93	74.4
	51 – 60	19	15.2	112	89.6
	≥ 60	13	10.4	125	100.0
Marital status	Single	45	36.0	45	36.0
	Married	80	64.0	111	100.0
Educational status	Primary	37	29.6	37	29.6
	Secondary	49	39.2	86	68.8
	Tertiary	39	31.2	125	100.0
Household size	< 4	40	32.0	40	32.0
(Mean = 4,	4 – 6	59	47.2	99	79.2
SD = 2.28)	> 6	26	20.8	125	100.0
Years of poultry farming experience	5 – 10	63	50.4	63	50.4
	11 – 15	17	13.6	80	64.0
(Mean = 6.65,	16 – 20	3	2.4	83	66.4
SD = 5.02)	≥ 20	42	33.6	125	100.0
Flock size	< 500	70	56.0	70	56.0
(Mean = 542 birds	500 – 1,000	37	29.6	107	85.6
SD = 327 birds)	> 1,000	18	14.4	125	100.0
Net Income ($/prod cycle)	< $3,000	98	78.4	98	78.4
(Mean value = $4,140)	$3,000 – $7,000	6	4.8	104	83.2
	> $7,000	21	16.8	125	100.0

Source: Data Analysis, 2019

Table 1 showed that male farmers were dominant (about 62%) in the egg-farming sub-sector of the livestock industry in the study area (in agreement with the findings of Iheke and Igbelina, 2016), majority (over 60%) of whom were within the active age group of 30-60 years with a mean value of 40 ± 15 years. About seventy-four (74%) of the poultry farmers had acquired post-primary school education (in consonance with Obayelu et al., 2017), and married (64%) with mean household size of 4 ± 2 persons. The mean flock size of poultry farmers in the study area was 524 ± 327 birds (layers stock only), each farmer having been involved in active poultry egg farming for an average of 6 ± 5 years, with an average gross income of $4,138 per egg [4]production cycle. The mean household size of 4 persons posits the possibility of

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[4] 1USD ($) equals 360 Nigerian Naira (₦) approximately as at 2019, the year of data collection

household labour supply response in the case of cyclical labour shortages characteristic of the study area due to attractions of labour force to non-farm income activities. Farmers' years of schooling combined with their poultry farming experience are key factors to enhancing level of risk awareness and mitigation strategy adoption to guarantee high risk survival rate, and promote farm resource-use efficiency and productivity (Ajibefun, 2006 and Ojo, 2003).

5.2 Farmers' mitigation responses and risk survival propensity rating in the study area

The result presented in Table 2 shows the main sources of risk in poultry egg farming as reported by the farmers (in consonance with the general risk sources in agribusiness as posited by Salman et al., 2014). From the findings, identified major risk sources in poultry egg farming in the study area were disease epidemic; egg glut shocks; adverse weather condition; and shocks of input price instability. Adeyonu et al. (2021) in a study that assessed risk perception and management among discovered disease outbreak and egg price fluctuations to be the two most striking risks confronting poultry farmers in south west Nigeria. Prices of egg tend to fall whenever there are gluts on the farm and in the market. In its own, disease outbreak shocks has a risk survival propensity (RSP) value of 45.50%, implying that a poultry farmer has about 46% chance of surviving a disease outbreak situation by strictly adhering to standard routine vaccination programme and regular drugs administration. The risk of egg glut shocks can be overcome about 39% of possible occurrences when a farmer secures an advance sales arrangement with buyers of egg and other related poultry products. Weather-related risk can be survived about 52% of occurrences by carefully planning stock arrival periods (especially layers stock raised from day old); while poultry egg farmers can survive the shocks of input price instability up to about 60% of occurrences by making advance purchase arrangements for major inputs (feeds and drugs/vaccines) in large/wholesales quantities.

As was earlier reported by Adeyonu et al. (2021), the results in Table 2 identified input price instability and adverse weather condition shocks as unexpectedly assuming high risk potentials status (68.8% and 67.2% respectively), though their mean (average) mitigation response scores were relatively higher (2.21 and 2.01), ostensibly resulting in the correspondingly high risk survival propensity values of 59.67% and 52.26% as were recorded. This finding suggests that the lead (best) mitigation strategy options (see Appendix) were inadvertently adopted most often for each of these two referenced risk categories. On the other hand, disease epidemics and egg glut shocks were observed to have posed lesser risk potentials to the farmers (48.8% and 56.8% respectively) and expectedly, they recorded lower mitigation response scores (1.82 and 1.85) which may have informed the relatively lower risk survival propensity rates (45.50% and 38.85%) recorded, though the lead mitigation strategy options were also being adopted by the farmers for these categories of farm risk.

Table 2. Distribution of farmer's risk exposure and risk survival propensity rating

Major risk sources/factor	P_i >50% (High risk potential)		P_i < 50% (Low risk potential)		P_i = 0% (Zero risk potential)		ROF	rROF	Mean MRS	RSP Value
	High Risk Freq.	%	Low Risk Freq.	%	Zero Risk Freq.	%				(%)
Disease epidemics	43	34.4	61	48.8	21	16.8	83.2	0.25	1.82	45.50
Glut of egg in the market	71	14.4	18	56.8	36	28.8	71.2	0.21	1.85	38.85
Adverse weather condition	84	67.2	28	22.4	13	10.4	89.6	0.26	2.01	52.26
Input price instability	86	68.8	33	26.4	6	4.8	95.2	0.27	2.21	59.67
							339			

Source: Data Analysis, 2019

5.3 Influence of selected socio-economic and farm-level factors on egg farmer's choice of risk mitigation strategies

The regression analysis was estimated to determine the influence of farmer's demographic, farm level/production and farmer's risk attitude to choice of risk mitigation strategy adopted by the poultry farmer. The outcome variable was the response to the poultry farmer's choice of a risk mitigation strategy. Result of the analysis is as presented in Table 3.

5.3.1 Disease epidemic risk category

The adjusted coefficient of determination (R^2) is 0.579 indicating that 57.9 percent of the variation in the farmer's propensity of mitigation strategy choice is explained by the specified variables with the F-statistics value (3.572; p<0.01) indicating a good fit for the model. As reveled in Table 3, poultry farms that are particularly located far from the sources of medical services (2.974; p<0.01), and those that are relatively accessible to service to egg buyers (1.682 p<0.1) would likely adhere more strictly to routine vaccination programme and regular drugs administration as a strategy to mitigate against disease outbreak shocks; but risk-neutral farmers would likely be indifferent to this risk mitigation

measure (-1.915; p<0.1). These results were in line with documented research outcomes on similar subject. For instance, a study by Adepoju et al. (2013) revealed that most poultry farmers in remote parts of Nigeria often engage the services of veterinary doctors to ensure their farms are free from disease attacks. Also, Adeyonu et al. (2021) reported timely medication/vaccination intervention as key factors in minimizing risks that are linked with high morbidity and

mortality in poultry enterprise. In their own study, Ullah et al. (2016) identified geographical location as influencing the relative significance of risk factors, while farmers' risk perceptions and access to public (such as animal healthcare) services determined farmers' choice of risk management strategies.

5.3.2 Egg glut risk category

The adjusted coefficient of determination (R^2) of 0.697 indicates that 69.7 percent of the variation in the farmer's choice of mitigation strategy is determined by the specified variables with the F-statistics value (4.845; p<0.01) indicating a good fit for the model. From the findings in Table 3, female farmers (-2.383; p<0.05), farmers with high background risk - worth of non-capital assets - (2.655; p<0.01), and those that are well experienced in the business of egg production (2.780; p<0.01) would more likely adopt advance sales arrangement for farm egg as a veritable mitigation strategy against egg glut shocks. This confirms the findings of Akinbile et al. (2013) which identified freedom from financial stress as a strong determinant of the choice of mitigation strategies against risks threatening poultry farmers' livelihood. Likewise, from the findings of Adeyonu et al. (2021), years of experience would positively influence the choice of mitigation strategy against disease and financial risk, which in themselves can arise as a result of incessant egg glut on the farm or in the market.

5.3.3 Adverse weather (condition) risk category

The adjusted coefficient of determination (R^2) is 0.737 indicating that 73.7 percent of the variation in the farmer's risk mitigation strategy choice is determined by the specified variables with the F-statistics value (3.709; p<0.01) indicating a good fit for the model. Table 3 equally showed that education (2.173; p<0.05); worth of non-capital assets (1.775; p<0.1); and long experience in egg poultry farming (2.040; p<0.05) would positively influence farmer's adoption of proper stocking time for layers as a worthwhile strategy to mitigate the adverse effect of weather condition on the farm. This equally validates the positive significant effect of increased years of farming experience on the choice of risk mitigation strategy option, as reported by Adeyonu et al. (2021). However, male farmers (-3.817; p<0.01) against *a priori* expectation, and farmers with indifferent attitude to risks (-2.228; p<0.05) would likely not engage in this practice as a way of curbing the negative effect of bad weather, confirming the strong collinear relationship earlier established by previous studies between the sex of poultry farmers and their risk attitudes (e.g. Iheke and Igbelina, 2016).

5.3.4 Price instability risk category

The risk model for price instability displayed a poor behavioral feature with an adjusted coefficient of determination (R^2) is 0.022 (showing no deterministic variation of the specified variables on the farmer's risk mitigation strategy) and a non-significant value of F-statistics 0.752 (showing poor fit for the model). The poor characteristic fitness of this price instability risk behavioral model is equally revealed in the significance of only the education variable as positively influencing the likelihood of adopting advance/wholesale input purchase arrangement (especially for feeds and drugs/vaccines) as a strategy to curb the shocks arising from input price instability. The observed weak significance of the input price instability dimension to risk shocks management in the study area negates the findings from earlier studies (e.g. Salimonu and Falusi, 2007; Effiong et al., 2014) that input/output price fluctuations were prominent among popular risk sources confronting poultry farm enterprises in Nigeria.

Table 3. Risk behavioural model (RBM) estimates of the determinants of farmer's probability of risk mitigation strategy adoption

Symbol	Variables	Disease epidemic risk category		Egg glut risk category		Adverse weather risk category		[5]Price instability risk category	
		Coeff.	t-value	Coeff.	t-value	Coeff.	t-value	Coeff.	t-value
	(Constant)		10.034		10.229		14.740		8.364
S_1	Sex	-0.139	-1.416	-0.249	-2.383**	-0.372	-3.817***	-0.056	-0.507
S_2	Household size	-0.007	-0.067	-0.027	-0.257	0.061	0.617	-0.137	-1.228
S_3	Educational level	0.194	2.276	-0.037	-0.409	0.184	2.173**	-0.164	-1.712*
S_4	Years of farming experience	-0.009	-0.112	0.250	2.780***	0.171	2.040**	0.119	1.257
X_5	Worth of non-capital assets	-0.112	-1.331	0.059	2.655***	0.149	1.775*	-0.054	-0.568
X_6	Flock size	-0.124	-1.367	0.050	0.519	0.017	0.188	0.049	0.479
X_7	Distance to medication/healthcare services	0.129	2.974***	0.073	0.839	0.086	1.056	0.029	0.314
X_8	Accessibility to farm location	0.141	1.682*	0.027	0.306	0.052	0.625	-0.014	-0.154
Z_9	Risk-neutral farmers	-0.179	-1.915*	-0.103	-1.034	-0.207	-2.228**	-0.031	-0.300
Z_{10}	Risk-averse farmers	-0.071	-0.644	-0.026	-0.217	-0.027	-0.250	0.048	0.389
Z_{11}	Risk-preferred farmers	-0.077	-0.710	-0.079	-0.682	0.002	0.021	0.043	0.356
	F-value		3.572***		4.845***		3.709***		0.752
	R^2 value		0.580		0.822		0.765		0.068
	Adjusted R^2 value		0.579		0.697		0.737		0.022

Source: Data Analysis, 2019

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[5] The price instability risk model displayed poor behavioral features (R^2 = 0.022, showing no deterministic variation of the specified variables on the farmer's risk mitigation strategy) and a non-significant F-value of 0.752 (showing poor fit for the model). Thus, it is dropped from the risk analysis for the respondents in the study area

6. SUMMARY AND CONCLUSION

The spate of rising and unstable prices of poultry farm inputs and the insecurity situation in many parts of Nigeria have further deepened the risk matrix of poultry egg farmers, causing many of them to quit the farming business, many farmers themselves falling into poverty traps, and consumers of livestock products facing increasing food (protein) commodities (Omolaja, 2018). Both the crop and livestock sectors have been threatened by this development, and especially the poultry and poultry (egg) sector known for its fragility and risk vulnerability (Adeyonu et al. 2021). With a male dominated poultry egg sector, the study area comprised fairly educated and experienced farmers largely within the active age bracket group of 30-60 years, operating on a small to medium scales that generated an average gross income of $4,138 per egg production cycle (about $345 per month).

The respondent poultry egg farmers in the study area identified the major risk sources to their poultry farm enterprises mainly as disease epidemic; egg glut shocks; and adverse weather threats, while input price instability shocks were also identified but of less empirical significance to the study area. However, the high risk survival propensity (RSP) value of 59.67% recorded for this less significant (input price instability) shock, was an indication of the sensitivity and response of the poultry farmers to the unstable and increasing price regime of major poultry farming inputs (especially feeds and drugs/vaccines), mitigated by adopting advance/wholesale input purchase strategy for those inputs. However, the lower risk survival likelihood rates accompanying the mitigation options adopted for other more potent risk categories in the study area (45.50% for disease epidemics) may have resulted from the difficulty of farmers and egg buyers to afford the prices of drugs, vaccines and medical service charges equally for the reason of increasing prices of these inputs. For the low risk survival propensity recorded in mitigating egg glut shocks (38.85%), the lead option of advance sales arrangement with egg buyers may equally fail as a result of the high costs incurred in the purchase and resale merchandise arising from inaccessible road conditions, associated marketing service costs, and the consequent inability of the egg merchants to break even. This scenario equally exposes the egg merchants/traders to the physical risk of likely egg breakages in transit, as well as the market risk of income/trade fund losses.

6.1 Recommendations

From the findings of the study, the following policy recommendations were made:

1. Since establishment of poultry farms is within policy-regulated enclaves and distances given the rapid development potentials around the study area, localization of poultry service farms/firms should also be consciously encouraged within a close range to guarantee timely and less-costly access to the poultry egg farmers. These service farms/firms include feed mills, drugs and vaccines sales outlets, and hatchery, among other essential inputs;

2. Accessibility of egg buyers/traders and service providers (e.g. veterinary/healthcare services, extension agents, etc) to farm locations should be enhanced through infrastructural development interventions (such as serviceable roads, veterinary/healthcare posts, and essential facilities for the farm families). The localization of the poultry sector industry to reserved and policy-regulated areas as is being operational in the study area will easily facilitate these provisions by the synergic intervention by government, poultry associations, and self-help community efforts.

3. Availability of non-capital assets by way of sound management is a major prerequisite for the survival of the poultry egg industry. As such, proper planning for the arrival of replacement stocks, vaccination programme, and egg sales arrangements must be put in place to guide against the adverse risk conditions identified among poultry egg farmers in the study area.

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Classification of specific mitigation strategy options within each reported risk category

S/No.	Major risk category	Risk mitigation strategy options
1.	Disease outbreak epidemics ($k = 2$)	[a]Strict adherence to routine vaccination programme and regular drugs administration
		Sound hygienic methods of poultry waste management
2.	Egg market glut ($k = 2$)	[b]Advance sales arrangement for egg produced on the farm
		Adoption of off-takers for farm eggs at the peak production period
3.	Adverse weather condition ($k = 3$)	[c]Observing appropriate timing and frequency of bird stocking
		Provision of adequate quantity of water to birds during hot weather/heat conservation during the wet season
		Keeping layers in standard housing structures
4.	Input price instability ($k = 2$)	[d] Advance/wholesale arrangements for the purchase of major farm inputs (mainly stocking birds, feeds and drugs/vaccines)
		Milling of own use poultry feeds

Source: *Field Survey, 2019*

[a,b,c,d] The lead risk mitigation strategy option with the highest response score in each risk category (in the numerical order of listing)