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MORTALITY RISK SEVERITY, ASSOCIATED FACTORS AND APPROPRIATE MANAGEMENT OPTIONS IN POULTRY AGRIBUSINESS IN DELTA STATE, NIGERIA

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ABSTRACT: *Biosecurity problems are among the most important challenges confronting poultry farms in Nigeria. Adequate empirical information on biosecurity is needed for effective risk management and productivity in poultry agribusiness This study examines mortality risk severity and biosecurity factors in poultry. Two hundred and ten respondent poultry farmers were randomly selected for the study. Structured questionnaire was the instrument used for data collection. Collected data were subjected to statistical analysis (mean, standard deviation, percentage and multiple regression model. The results show a mortality rate of 12% . Risk severity (expected revenue loss due to risk) is N23, 010 per production cycle per farmer. Bioexclusion and biocontainment factors jointly explained 98% variation in mortality risk in poultry farms. Regression results show that litter replacement frequency (0.60)*, stocking density (0.87)*, available biosecurity infrastructure (0.61)* and routine cleanliness (0.53)* are significant biosecurity factors (p<0.05). We conclude that poultry farms vary sharply in their susceptability to mortality risk depending on available biosecurity management techniques practiced by the poultry farmers. Biosecurity practices will translate to increase revenue generation and progress in poultry industry. We recommend regular workshops on biosecurity management practices to be organised by the government and relevant agencies for poultry farmers in Nigeria.*

KEYWORDS: Biosecurity; Bioexclusion; Biocontainment; Poultry; Risk.

INTRODUCTION

Biosecurity **or** preventive measures are designed to reduce the risk of transmission of infectious diseases in livestocks including poultry birds (Koblentz, 2010). Poultry production is fraught with risks, since producers are dealing with biological orgarnisms. Risk is the potential loss of funds between the beginning and the end of the an investment period (Warwick, 2003); a decline in an organization's total income (Gregoriou, 2006), loss to an organization (Horcher, 2005) the uncertainty of achieving desired results of an organization (Keegan, 2004), an event or circumstance, that if occurred, would negatively affect the achievement of the project objectives (Chamban, 2003), and an unexpected loss (Condamin, *et al.*, 2006).

Modern poultry production systems, biosecurity involves all the measures that are adopted to secure poultry farms from disease incursions and spread. Disease outbreaks in poultry leads to mortality, reduced output and profit fluctuations (risk shocks). Consequently, poultry production system is undergoing continous modification by farmers to wedge against failure through various biosecurity measures. The term **"biosecurity**" has been used widely in the debate on avian influenza (FAQ, 2004a, Thieme, in FAO, 2007a; Otte *et al*., in FAO, 2007b). In essence, it describes the sum of the measures taken to prevent incursion and spread of disease. In this study, this term refers to the management measures taken to manage the risk of

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incursion of disease causing organisms into individual farms (**"bioexclusion**") and to reduce the risk of onward spread to nearby poultry farms if infection has taken been diagnosed ("**biocontainment**").

Therefore, there is need for determination of mortality risk and the biosecurity management practices adopted by poultry farmers for improved performance in the poultry industry. Also empirical information on the level of production risk is important to poultry farmers and government for the purpose of planning and development programs for the poultry sub-sector of the economy.

Each individual poultry farm or flock, has its own risk profile for the introduction of pathogens, subsequent development of disease, and spread of disease to other farms. This is influenced by a number of factors, including: the density of farms (Marangon *et al.,* 2004), especially for agents in which rate of transmission is density dependent (e.g. airborne spread) (Truscott *et al.,* 2007); and the linkages between different farms through production and market chains, which may lead to disease transmission that is density independent.

This research examines poultry production systems, discussing the risks they face and the risk they pose with regard to animal diseases. It provides information on the poultry systems' key weaknesses and strengths in relation to disease prevention and spread, with special emphasis on biosecurity measures employed on farms. It models the interaction between the threat of diseases on output and profitability in poultry production systems. It also considers how these risks can be assessed and managed.

Hence assessing the risk in commercial broiler enterprise will require an understanding of the factors which impact on its output and returns so that existing and prospective investors can watch out for these factors in the production process. An empirical investigation of the impact of these risk factors is an important research issue in the face of contradictory findings by previous researchers on the variability of returns in poultry farmers in Nigeria. Considering these scenarios, an important research issue that is worthy of investigation is the Forecast-Based Production Risk Assessment and Management Approaches in Poultry Production in Delta State, Nigeria.

Biosecurity problems are among the most important problems facing poultry farms and may affect the economic security of the country unless serious reserach efforts are made to improve the system. Poultry production is one of the most important sources of food security and poverty alleviation. Without efficient biosecurity management, the realization of goals of Food Security and Poverty Alleviation through the poultry sub sector, will not be feasible in Nigeria.

There is the existence of large gaps in information on biosecurity among poultry farmers in Nigerian. Most farmers focus on preventing entry of pathogens and less about preventing onward spread. This is an issue of major concern in areas with high poultry farm density. Enhancing biosecurity as an option for production risk management requires empirical data, self interest, persuasion, necessary infrastructures cost and skills for managing disease exclusion and containment, communication of the right message and buying of insurance policy. Developing a biosecurity model that provides the basis for the relevant elements is crucial to progress in poultry secror.

Since mortality risk is critical to output and revenue in poultry business, it can adversely influence investment decision. Hence accurate forecasting of production risk may boost the

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confidence level of investors in poultry industry. Risk and its ugly effects in poultry subsector could create instability in the nation's economic indices, such as GDP.

Certain aspects of risk management standards have come under criticism for having no measurable improvement on output. These criticisms are often based on the confidence in risk estimates that are not often used by poultry farmers in production decisions. The widespread practice of smallholder poultry keeping in Nigeria, is frequently cited as one of the primary risk factors in domestic poultry populations. Thus, some governments are taking measures to increase 'biosecurity' of smallholder poultry production. Many of these biosecurity measures may be expensive for resource-poor smallholder producers and thereby could force them to abandon poultry keeping. Given these likely adverse impacts of risk on smallholder poultry growers, it is important to examine the evidence base for such measures in terms of mortality risks.

As it stands, poultry farmers face some difficulties in allocating required resources efficiently in biosecurity. Resources utilized for risk management have alternative uses.This is the opportunity cost of risk management resoruces. When scarce resources are over utilized in risk management, it tends to reduce the profit earned by the farmers. Resources spent on risk management could have been spent on more profitable economic activities. Practical implementation of biosecurity requires resources which may constitute additional cost to production practices of the farming system. Thus, there is the need to identifyy the main risk factors, quantify risks and assess of the efficacy and cost of biosecurity/risk mitigation measures. The adoption of measures which do not significantly reduce the risk but place severe economic burdens on poultry farmers may be economically unjustifiable There is the need to determine cost of efficient risk management practices and how it translates to increased poultry output.

Inability of farmers to identify risk factors that predispose poultry production to mortality risk and can cause high catastrophe. There is need to improve the knowledge of poultry farmers with, respect to the management of poultry risk factors. Efficient risk management. has the dual advantage of increasing output and increasing profit. Hence an important research issue that is worthy of investigation is the forecast- based risk assessment and management appraches in poultry production systems in Delta State, Nigeria

Attracting investment to this subsector would require the knowledge and information on production risk. Forecasting poultry risk will arouse the consciousness of poultry farmers on risk mitigation. Many risk- related disasters illustrate a regrettable fact. Poultry farmers continue to suffer and poultry enterprises are folding up due to predictable production risks. This study provides information on how poultry managers/farmers at risk engage in meaningful dialogue to develop feasible approaches and tools for risk analysis and management. The study demonstrates how to develop new approaches to forecast risk and early mitigation actions are taken before risk havoc happens. It is imperative to plan for forecast-based decisions to act (or not to act) by systematizing knowledge, making full use of scientific information on all time scales.

The output of this study is intended to improve risk experts decisions concerning the future. The result of this study is intended to serve as a useful guide for poultry farm planning and agribusiness advice in agricultural extension package. The study is of great benefit to potential and existing investors, insurance institution, institutional lenders and other stakeholders for the overall development of poultry industry in Delta state, Nigeria. The finding of this research is

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also intended to strengthen the bulk of agricultural risk theory and enrich existing literatures. The outcome of the study is expected to open up new vistas for similar research works in the future.

The specific objectives of the study were to:

i. ascertain the motality risk level in poultry production system.
ii. determine production risk severity in poultry.
iii. assess the impact factor of biosecurity in poultry production risk.

The following hypothesis was formulated and tested to guide the study:

Ho_1: The selected biosecurity factors do not have significant effect on risk level in poultry production system.

MATERIALS AND METHOD S

Description of Study Area

Delta State of Nigeria was the study area. The area was chosen for this study due to the substantial presence of poultry farms. Poultry production is an important economic activity that attracts substantial proportion of investment of both the rural and urban populace in Delta State. Delta State is an agriculturally advantaged state. The state has a total population of about 4,098,391 people that depend on poultry industry for the supply of animal protein. The major economic activity of the people is farming. The livestock commonly reared include poultry both on small and large scales. Mortality is a common problem in poultry businessin the area, causing unsteady output and unstable farmers income.

Sample size and Sampling Technique

This research enquiry was targeted at the population of all brioler poultry farmers in Delta State, but **t**o avoid selectivity bias, a chance mechanism was employed to select sample of 240 farmers for the study. Probabilistic procedure (multi-stage procedure) was considered appropriate because, with this method, every agro-ecological zone, L.G.As and every commercial poultry farmer in the study area had equal chance of being selected for the study. The procedure for multi-stage sampling technique that was adopted in the study is as follows:

Stage I: Selection of L.G.As. Four L.G.As were randomly selected from the list of the L.G.A. in each of the 3 agro-ecological areas. This gave a total of twenty L.G.A. out of the 25 L.G.As. This gave 48% of the total that were captured in the study.

In each of the twelve selected L.G. As, ten broiler farms were selected.. The list of registered farmers formed the sample frame for the study. Also only farmers that have been in operation for at least 5 years previously were chosen for the study.

Data Collection Techniques

Panel data of cross sectional observations were collected from respondent farmers over a period of years (2008- 2012). Best forecast results are generally obtained using historical data. There

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is no clear 'best' length of period. Valderama and Engle (1999), made use of a 3 years historical data in their study. Ahmad *et al.,* (2005) made us of 19 years regional annual data.

Data were collected on poultry mortality rate; poultry output, risk management approaches for five years (2008-2012). Information was also collected on cost and returns to operation and factors that determine risk in poultryproducton systems.

Data Analysis Framework

Collected field data were subjected to statistical analysis using mean, standard deviation percentage and regression model.

Determination of Mortality Risk in Poultry Production

$$\% \text{ Mortality} = \frac{\text{Total number of dead birds}}{\text{Total number of birds stocked}} \times \frac{100}{1}$$

Biosecurity factors in Poultry Production System

Model specification

The implicit form of the multiple regression models takes the form:

$$Ø = f(X_1, X_2, X_3, ,,,, Xn) + \mu \ldots\ldots\ldots(1)$$

Three functional forms were estimated using Ordinary Least Square technique of multiple regression, namely: Linear, Semi-log and double log functions.

The most appropriate on the basis of R^2 value and nunber of significant exogenous variables, was chosen as the lead model The explicit form of the linear function takes the form:

$$Ø = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \div \beta 4 X_4 + \beta_5, X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \mu \ldots\ldots(2)$$

Where:

Ø = Observed mortality risk (%)
X_1 = Frequency of litter change (number)
X_2 = Effect of breed of bird stocked dummy of 1 for yes, o' otherwise
X_3 = Biosecurity infrastructures availaible (number)
X_4 = Adherence to recommended vaccine schedule (rank of 1-5 points)
X_5 = Feeding regime
X_6 = State of nature (Dummy of 1 for climate impact o' otherwise)
X_7 = Stocking density
βo = Intercept term
β_1-β_7 = Coefficient of parameters estimates

RESULTS AND DISCUSSION

The result of the study shows that average Mortality Risk levels in Poultry production cycles, derived from standard deviation (SD) of mortality rates is:

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S.D = (0.001176) > (0.00004) < (0.2408) > (0.0430) > (0.0008) < (0.2017)

Average Risk = 0.12 (12%). This result implies that for every 100 birds stocked, 12 birds are likely to die. In poultry farm planning, farmers are to exclude 12% from the stock before determination of the expected output. The remainder is the certainty output and revenue.

Risk Severity in Poultry Production System

Mortality risk severity in this study was used to quantify the likelihood (frequency) and impact (consequence) of identified production risk response or sensitivity. The procedure is first to evaluate the risk probability, secondly, to determine the potential of consequences. Overall loss associated with risk was estimated by multiplying the expected severity of mortality risk by the probability of the loss.

The result of the study shows that

Total stock raised = 23,760 birds

Survival = 20,692 birds

Mortality = 3,068 birds

Severity = (3068) ₦1500

= ₦4,602,000

Expected severity = ₦4,602,000 (0.129)

= ₦593,658

Expected revenue

23,760 x 100 = ₦ 35,640,000

Actual revenue

N20,69x15,000 = ₦ 31,038,000

Mean Actual = ₦155,190

Revenue short fall due

To risk at ₦35,640,000 minus - ₦31,038,000

Industry level = **₦4,602,000**

Mean

Revenue loss

due to risk = **₦23,010**

at farm level

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Assessment of Biosecurity Factors and impact on Poultry Risk.

$Ø = f(X_i, X_j,)$.....(3)

Where:

X_i = bioexclusion factors,
X_j = biocontainment factors,

The identification and impact assessment of biosecurity factors on mortality risk in broiler industry was estimated with the use of ordinary least square technique of regression analysis as shown in Table 1. The linear function was chosen as the lead model on the basis of R^2-value (98%) and number of significant factors in the model.

Table 1:Coefficients of Biosecurity Factors in Poultry Production

	Linear Function		Semi-Log Function		Double-Log Function	
Variables	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat
Intercept	0.204	42.089*	0.509	18.89*	0.427	3.326*
Litter Replacement Freq.	0.60	2.617	0.005	1.63	0.022	1.432
Stocking Density	0.87	3.724*	0.003	2.41*	0.014	2.38*
Breed	0.361	0.755*	-0.004	1.16	0.033	1.85
Evidence of theft	0581	2.350**	0.0002	0.62	0.0007	0.35*
Proximity to other poultry farms	0.402	1.562	0.041	0.541	0.024	0.67
AvailableBiosecurity Infrastructure	0.613	4.528	0.042	0.342	0.341	0.324
Disease outbreak	0.630	3.528*	0.003	3.68*	0.021	6.65*
RoutineCleanliness	-0.533	-4.19*	-0.0003	-0.368	0.194	5.07*
Routine medication	-0.621	0.423	0.0241	0.267	0.423	4.21
R^2 = 0.984			R^2=0.971		R^2=0.918	
R^2(adj.) = 0.968			R^2(adj) = 0.96		R^2(adj) = 0.915	
F-stat=646.03			F-stat = 558.3		F-stat = 239.12	
*= Significant at 1%			*=Significant at 1%		*=Significant at 1%	
**=Significant at 5%			**=Significant at 5%		**=Significant at 5%	

Testing of Hypothesis

H_0: *The selected biosecurity risk factors do not have significant impact on mortality risk in broiler production in the study area.*

i.e. $\beta_1, = 0, \beta_2 = 0, \beta_3 = 0, \beta_4 = 0, \beta_5 = 0, \beta_6 = 0, \beta_7 = 0$

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T-statistics was used to test the significance of the coefficients of risk factors estimate.

Out of the nine factors captured in the model, seven were significant and entered the model with a priori expectations. These variables were litter management, stocking density, breed evidence of theft, proximity to other poultry farms, disease attack, routine, clealiness, timely medication, available biosecurity infrasructures. The coefficients of the factors in Table 1 were converted to percentage impact factos by multiplying each coefficient by 100. This is the scoring system used to generate Table 2. A Risk impact factor that is below 50% is considered low, 50% to 59% is moderate, 60% to 69% is high, while 70% and above is very high.

At this point, the assessments of key risk impact factors are discussed in relation to percentage impact on mortality risk in broiler industry.

The distribution of assessment of mortality risk factors is presented in Table 2.

Table 2: Distribution of Assessment of Risk Impact Factors and management decisions

S/No	Risk factors	Risk Impact factor(%)	Risk Assessmt Rating	Risk Mgt Decision
1	Litter replacement	60	high	take early action
2.	Stocking density	87	very high	do not accept
3.	Breeds effect	36	negligible	accept and manage
4.	Evidence of theft	58	moderate	anticipate and prevent it,
5.	Proximity to other poultry	40	low	accept if benefit outweighs cost
6.	Biosecurity infrastructure	61	high	supply risk mgt resources
7.	Disease outbreaks	63	high	early diagnosis & consult vet.officer
8.	Routine cleanliness	53	moderate	early action
9.	Time lag in medical intervention	62	high	Comply to medication schedule

(Source: 2013 Field data)

Stocking Density

This variable entered the model with a postive impact factor of (87%) indicating that the higher the stocking density, the higher the reduction of risk impact on broiler producers. This result implies that with high stocking density, the producer could have enough left over stock to cushion the effect of risk should there be incidence of disease outbreak and mortality. The left over stock could generate liquid asset than can sustain the farm from complete collapse due to risk shock. The reverse could be the case with small stock density. This finding has demonstrated that high stocking density of birds could serve as a useful hedge against mortality risk shock.

Evidence of Theft

This parameter was positive and significant in the model. Evidence of theft or pilferage when it is frequent in broiler industry could have devastating effect on farm financial. The positive coefficient (58%) indicates that the more frequent the evidence of theft in a poultry farm the more the mortality risk. Hence the result of this study has demonstrated that evidence of theft is one of the key non systematic risk factors in broiler enterprise. Pilferage risk is a calculable risk that can be insured provided the actual loss can be determined. According to Anonguku *et al* (2008), livestock pilferage constitute a serious menace and its effect include financial loss (68% and 65%) in urban and rural areas respectively in Bernue State. With proper management,

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however, in terms of effective control (security), pilferage risk will be drastically reduced in broiler enterprises.

Routine Medication

This variable termed out to be negative and significant in the model. This implies that mortality risk will be reduced as the farmer adheres to routine medication (53%) and best production practices. Such practices as vaccination, routine cleanliness, stocking of better breeds of birds, record keeping, better cost control and close contact with veterinary officers. When all the above practices are observed by broiler producers, risk will be drastically reduced in broiler poultry business. This is because best practices will reduce mortality; minimize cost of production and makes farmers to access market information on input and output prices. Thus as broiler farmers adhere to best practices, mortality risk will be mitigated in broiler industry in the study area.

Breeds of Fowl

The finding of the study revealed that breed of chicken raised has insignificant impact factor (36%) on mortality risk of broilers. Some breeds of fowl are prone to high disease attack. there is an increase in mortality rate among such birds at the early stage. This is in conformity with Awobajo et al. (2007), who observed that,with proper choice of breeds of broiler at brooding stage, broiler producers could avert the danger of stocking breeds which are prone to high mortality,

Biosecurity Infrastructure

The impact factor of biosecurity infrastructure on mortality risk is significant ($p<0.05$). This implies that lack of biosecurity infrastructure is capable of creating risk impact of 61%. The biosecurity infrastructure include :Fence present around the farm yard perimeter Foot dips present ,Presence of paved place of discharge**,** Number of multiple cages are kept together. Farmers are to make sure that relevant biosecurity infrastructures are provided.

CONCLUSIONS/RECOMMENDATIONS

Chickens, which are mostly raised by the majority of households in the different villages in Nigeria, have the potential to increase income and generate employment, as well as contributing to the national supply of meat and eggs. It was generally observed that, higher mortality rates could be reduced substantially through substandard biosecurity management practices. Further more, the study concluded that farms face very high risks because of their stock size. Disease outbreak and time lag (delays) before taking medical interventions created high risk impact. If poultry farms are infected, there is a high probability of subsequent local spread of infection, depending on the density of poultry farms in the neighbourhood. If poultry disease are to be contained, and perhaps even eliminated, all farms will be required to implement appropriate measures to minimize the risk of disease incursions and subsequent spread to other farms. This will require concerted efforts by government authorities and the private poultry farm owners. Ultimately, due to cost implications of biosecurity resources,the decision to step up biosecurity measures rest with individual farm owners.

On the basis of the findings of this study, the following recommendations were proffered:

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i. There should be sensitization seminar for poultry farmers on biosecurity approach to risk management in poultry production.
ii. Government should subsidize some biosecurity infrastuctures
iii. Extension agents should give quality information to farmers on the contact addresses of verterinary officers and the need to contact them early.

If all these recommendations are implemented, it will lead to tremendous development in the poultry industry.

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