RISK ANALYSIS IN FISH FARMING SYSTEMS IN OYO AND KWARA STATES, NIGERIA: A PROSPECT TOWARDS IMPROVING FISH PRODUCTION

[1]OLADIMEJI, Yusuf Usman, [2]GALADIMA, Sidi Ali, [1]HASSAN, Abubakar Abdullahi, [1]SANNI, Abdullahi Abubakar, [1]ABDULRAHMAN, Sani, [1]EGWUMA, Henry, [1]OJELEYE, Adebayo Oluwaseun and [1]YAKUBU, Ado

[1]Department of Agricultural Economics, Ahmadu Bello University, Zaria, Nigeria.
[2]Department of Agricultural Education, Umar Suleiman College of Education, Gashua, Nigeria.

Corresponding Author: Oladimeji, Y. U. Department of Agricultural Economics/Institute for Agricultural Research (IAR), Ahmadu Bello University, Zaria, Nigeria. **Email:** yusuf.dimeji@yahoo.com
Phone: +234 8032220000

Received: *February 27, 2019* ***Revised:*** *March 9, 2019* ***Accepted:*** *March 12, 2019*

ABSTRACT

The aim of this paper is to analyze risks in fish farming systems in Oyo and Kwara States, Nigeria. The primary data were collected using structured questionnaire with personal interview method by trained enumerators. The data collected belonged to the 2015/2016 production year. The total respondents (277) in the two states were separated to concrete pond fish farmers (123) and earthen pond fish farmers (154). Descriptive statistics, safety model and multinomial logit model were used to analyze the data. The results indicated that concrete system was more hired labour driven, relatively had higher formal education, and higher total investment and credit utilized compared to earthen system. The results of the risk preference revealed that of 123 respondents in concrete pond system, 52 % are risk preferring, 34 % are risk neutral and 16 % are risk averse, indicating better risk seeking compared with 154 respondents in earthen pond system with 21.4 % being risk preferring, 59.7 % being risk neutral and 18.8 % risk averse. The results of the estimates of the explanatory variables revealed that that the set of significant explanatory variables and their signs vary across the concrete and earthen pond systems. It would be concluded that the determinants of fish farmers'' risk status differ considerably between concrete and earthen pond systems. Fish farmers needs to be sensitized through seminars, workshops and trainings in seeking risk by extension personnel in collaboration with agricultural insurance firms, this will go a long way in improving fish production among respondents.

Keywords: Fish farming, Insurance, Marginal effect, Risk aversion, Workshops

INTRODUCTION

Aquaculture is the rearing of aquatic organism in enclosed water bodies such as ponds, pens, dams, cages, raceways, rice fields, tanks, reservoirs under control management. Specifically, fish farming is the culturing of fish in selected or controlled environments. In Nigeria, fish farming may have arisen as an intervention mechanism to enhance food production, employment or livelihood diversification since artisanal fishery that dominated the fish supply in the 1960s and 1970s is already overexploited with drastic reduction in fish catches. More importantly, fish is acknowledged as an important source of animal protein devoid of religious taboo or any known cultural limitation affecting its consumption unlike pork and beef, and fish is contributing significantly to the survival and well-being of a large number of the people in the country (Oladimeji *et al.*, 2017). In addition, the craving for fish is on the increase in Nigeria given its implication for individual and national health. Fish contains Omega III fatty acids that are known to reduce cardiovascular diseases, hypertension and arteriosclerosis, thus becoming a preferred source of animal protein for those about 50 years of age and above (Kris-Etherton *et al.,* 2002). Omega III fatty acids are also known to enhance good brain cell development in developing foetus, thus a vital diet for pregnant women and Intelligent Quotient (IQ) in developing children (Huffman *et al.,* 2011). Aquaculture may therefore be a veritable means of achieving protein security, alleviating hunger as well as curbing seasonal supply of fish products. Furthermore, it has the capacity of creating jobs since labour would be expected in all the associated industries.

It is pertinent to mention that increasing the fish farming production is needed to meet supply-demand deficit in Nigeria as the capture fisheries resources are declining due to over-exploitation, habitat destruction and pollution. However fish farming involves biological production process that are exposed to widely varying and unpredictable elements of nature, such as uncertainty in biological processes related to weather, diseases, pests, infertility which cause yield variability. The complex nature of weather and climate as well as physical and environmental factors make fish farming enterprise more difficult to manage (Flaten *et al.,* 2008; Oladimeji *et al.,* 2017). Risk in fish farming are not only of production and technical in nature, but also related to socio-economic, financial, market and price, political, and human or physical induced risks (Figure 1). The fish farming enterprise is therefore, fraught with potential risks.

In other words, risk is the likelihood that harm or injury from a hazard will occur to specific individuals or groups exposed to a hazard. Thus, for every production process, there are associated risks no matter how well managed the system is. The aim of this paper is to analyze risks in fish farming systems in Oyo and Kwara States, Nigeria.

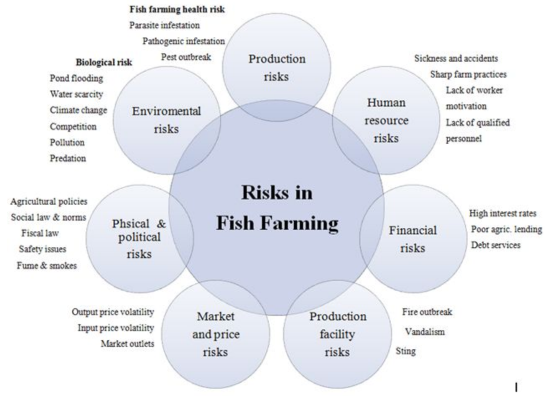

Figure 1: Classification of risks in fish farming (Adapted and modified from Theuvsen, 2012)

Specifically examine variability in economic return and estimate factors determining the degree of absolute risk aversion and risk preferences in fish farming systems.

MATERIALS AND METHODS

The study Area and Data collection: This study was conducted in Nigeria precisely Kwara and Oyo states in southwestern and north central respectively. The primary data were collected using structured questionnaire with personal interview method by trained enumerators. The data collected belonged to the 2015/2016 production year. Information on socio-economic and institutional characteristics, input and output, perception of risk and willingness to accept risk were obtained from the fish farmers to achieve the objectives of study.

Sampling Procedure and Sampling Size: Kwara and Oyo states were purposefully chosen because of influx of civil servants and youths venturing into fish farming in the two states (Oladimeji *et al.*, 2017). Before collecting data, a pre-test survey was conducted from a group of randomly selected fish farmers in the two States. Snowball-sampling technique through Agricultural Development Projects (ADPs) was employed to sample 127 respondents in Oyo State (Oladimeji *et al.*, 2018) and 150 respondents were sought for in Kwara state through random sampling (Oladimeji *et al.*, 2017). Thereafter, the total respondents (277) in the two states were separated to concrete pond fish farmers (123) and earthen pond fish farmers (154).

Analytical Techniques: Descriptive statistics: mean, standard deviation and coefficient of variation measured relative fish yield variability. The coefficient of variation (CV) equals the standard deviation (SD) divided by the mean. Safety model, which involve multiple regression analysis was used to determine the risk attitude coefficient of fish farmers. The factors that determine risk preferences in fish farming were accomplished by multinomial logit model using the three risk categories as dependent variables.

The safety first model involves the estimating of the Cob-Douglas Ordinary Least Square (OLS) regression analysis by identifying factors that possibly determine the degree of absolute risk aversion in fish farming in the study area.

The explicit form of the model is given as:

$$\ln Y = \alpha + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + \beta_7 \ln X_7 + \beta_8 \ln X_8 + e_i \quad \text{------------------------------------ (Equation 1)}$$

Y = The dependent variable was measured using Risk Behavioural Model (RBM) developed by Roy (1952) and modified in line with studies of Sekar and Ramasamy (2001), Salimonu and Falusi (2007) and Babalola (2014).

$$\Phi_i = \frac{(\lambda_i^* - \mu_i)}{\sigma_r} \quad \text{---------------------- (Equation 2)}$$

Where: Φ_i= risk aversion index; λ_i^*= attained level of average fish harvest/pond; μ_i= expected average fish harvest/pond from the farm; σr = standard deviation of fish harvest/pond; $i = 1 \text{ to } n$ while $n = 277$ fish farmers. The attained level of average fish harvest/pond (λ_i^*) represents the point below which the behavior of the decision maker must change markedly; the fish farmer must taken a rational decision to remain in the business or opted out. This level of fish harvest/pond would also be determined by the situation of the decision-maker in a given production environment (Sekar and Ramasamy, 2001). That is, the respective respondent fish farmer is a risk averter if $\Phi_i < 0$, if $\Phi_i = 0$, the fish farmer's attitude to risk is neutral and if $\Phi_i > 0$, the fish farmer is a risk seeker or preferred.

The exogenous variables fitted include: X_1 = pond size (m^3); X_2 = water (m^3); X_3 = feed (kg); X_4 = drugs (litre); X_5= family labour (man-days); X_6 = hired labour (man-days); X_7 = risk aversion (dummy); X_8 = risk neutral (dummy); α = constant, β_i = coefficients to be estimated and μ_i =error term associated with data collection from the i^{th} fish farm which was assumed to be normally distributed with zero mean and constant variance.

Specification of the Multinomial Logistic Model and Stochastic Dominance Analysis: Multinomial models are appropriate when individuals can choose only one outcome from among the set of mutually exclusive, collectively exhaustive alternatives. Using the three risk categories as dependent variables, factors that possibly determine risk preferences among fish farmers were estimated using a multinomial logit model (McFadden, 1974; Eggert and Lokina, 2007). Therefore, the probability that the i^{th} fish farmer belongs to the j^{th} risk behavior group reduces to:

$$P_{ij} = \frac{e^{\beta_j X_i}}{1 + \sum_{k=j}^{j} e^{\beta_j X_i}} \quad \text{------------- (Equation 3)}$$

Where $i = 1, 2 \ldots 277$ variables; $k = 0, 1, .. j$ groups; and β_j = a vector of parameters that relates Xi's to the probability of being in group j where there are $j + 1$ groups. The independent variables included in the model were X_1 = age (years); X_2 = experience in fish farming (years); X_3 = formal education (years); X_4 = household size (persons); X_5 = pond size (m^3); X_6 = credit utilized in fish farming (Naira); X_7 = cooperative society (years); X_8= amount invested in fish farming (man days); X_9= family labour (man days); X_{10} = hired labour (man days) and X_{11} = fishery status (dummy, if major occupation is fish farming = 1 and otherwise = 0).

In final regression analysis, two variables: credit and family labour was dropped. This was due to multicollinearity between credit and investment as well as household size and family labour. Therefore, Farrar glauber test to check the correlation matrix (CM) and find a matrix of pair wise coefficient of all independent variables was used to detect multicollinearity between the pairs of these variables. For the purpose of this study, any pair of correlation co-efficient that is up to 0.50 and above was considered as posing serious multicollinearity problems in line with study of Oladimeji *et al.* (2016). In addition, the Durbin Watson (D.W.) statistic was used to test for the serial correlation in the residuals denote by $E\ (Ut\ Ut-1)$. Therefore, DW of less than 1.5 was assumed to pose a serial correlation.

It is established in literature that the economic returns (income) of different fish farming systems define their risk exposure (Flaten *et al.*, 2008). The mean fish income was determined (Figure 2) and then was used to generate empirical distributions of financial outcomes and form the basis for classification as risk neutral, risk averse or risk seeking.

Deaton (1997), Hardaker *et al.* (2004) and Flaten *et al.* (2008) have pointed out that the best route to risk efficiency is by finding strategies that improve the expected values of returns, rather than those that cause dispersion. The study identified risk efficient solutions using first and second degree stochastic dominance criteria. In order to determine whether a relation of stochastic dominance holds, the distributions have to be characterized by their cumulative distribution functions (CDFs). Variability in economic returns within farms for each of the fish farm system was estimated by modifying Flaten *et al.* (2008) equation, used to generate empirical distributions of economic returns:

$$y_{it} = (\bar{y}_i - \bar{y}_p) \text{ --------------------- (Equation 4)}$$

where y_i is average yield of fish farm per pond, y_p is the pooled average output in the study area (average yield for all fish farms in the study area). An empirical distribution was chosen because it avoids forcing a specific parametric distribution (such as the normal) on the economic returns. The empirical economic return variables in this study were smoothed using a kernel density $K(.) =$ function estimator given as follows:

$$\hat{f}_h(x) = \frac{1}{n}\sum_{i=1}^{n}\frac{1}{h}K\left(\frac{x-x_i}{h}\right) \text{ ------- (Equation 5)}$$

Where: $H =$ is a bandwidth, $n =$ number of data points, kernel density and $X =$ economic returns. The aim of Kernel Density Estimation (KDE) is to find the Probability Density Function (PDF) for a given data set by smoothing the around values of PDF.

RESULTS AND DISCUSSION

Table 1 presents the summary statistics of the variables used in the analysis. The results indicate that concrete fish farming system was hired labour driven, had mean formal education of at least secondary education, and higher total investment and credit utilized compared to earthen fish farming system. Furthermore, the concrete system allotted more area to fish farming, which was permanently owned, and accepted fish farming system as major occupation. Several studies have demonstrated that socio-economic characteristics of household heads influence risk status and risk management in agricultural production (Eggert and Tveterås, 2004; Eggert and Lokina, 2007).

The results of the risk preference are presented in Figure 2. Out of 123 respondents in concrete farming system, 52 % are risk preferring, 34 % are risk neutral and 16% are risk averse, which indicates better risk seeking compared with 154 respondents in earthen pond system with 21.4% being risk preferring, 59.7% being risk neutral and 18.8% risk averse.

Table 1: Descriptive statistics of variables for responding fish farmers per 1000 juveniles

Variables	Description	Concrete Pond Mean	Earthen Pond Mean	Pooled Mean
Gender	A dummy =1 if male; 0, female	0.81(0.28)	0.95(0.11)	0.87(0.19)
Marital status	A dummy =1 if married; 0, single	0.72(0.57)	0.79(0.34)	(0.75(0.29)
Age	Age in years of the fish farmers	41.8(7.4)	49.2(9.0)	46.3(8.3)
Experience	Number of years engages in farming	11.6(4.1)	13.8(3.1)	10.0(3.0)
Education	Number of years spent in school	12.7(1.9)	11.1(4.7)	12.0(3.6)
Household size	Number of persons per fish farmer	6.9(2.2)	7.7(2.1)	7.0(1.7)
Pond size	Size of pond used in m3			
Credit (Naira)	Amount utilized in fish farming	0.23 m (0.039)	0.09 m(0.03 m)	0.08 m(0.03 m)
Cooperative	Number of years in agric. cooperative	13.6(3.8)	18.2(8.3)	15.6(5.5)
Extension/year	Number of visits received by farmers	4.6(3.8)	2.0(1.8)	2.8(1.9)
Investment	Amount invested in fish farming	0.77 m (0.047 m)	0.36 m (0.019)	0.45 m(0.27 m)
Hired labour	The man-days of hired labour/pond	33(4.7)	21(2.7)	29(1.8)
Family labour	The man-days of family labour	17(3.7)	45(4.4)	31(2.7)
Fishery status	A dummy =1 if fish farming & 0= No	0.76(0.21)	0.63(1.8)	0.64(1.5)
Fishery size	Area allotted to fish farming (m2)	0.54(0.62)	0.38(0.28)	0.43(0.34)

Number in parenthesis = standard deviation of mean, Naira, average ₦195 = 1US$ during survey, m = million

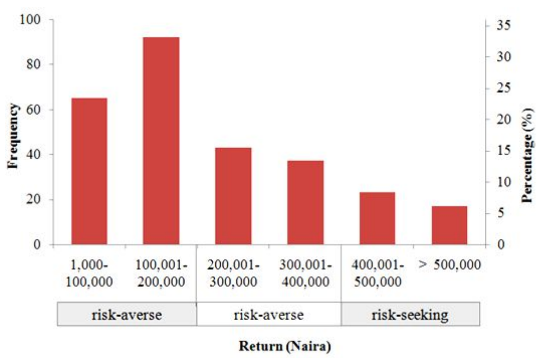

Figure 2: Classification of fish farmers based on economic return and their risk-taking attitude. Naira, average ₦195 = 1 US dollar during the survey

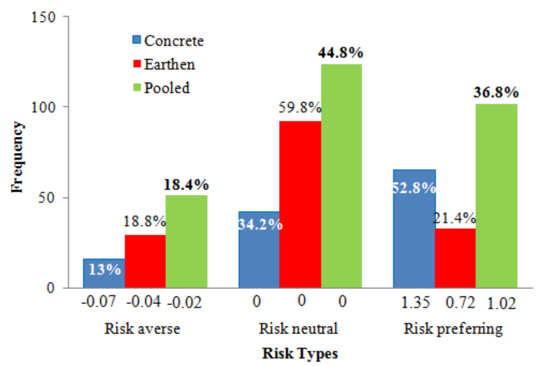

Figure 3: Distribution of fish farmers by risk preference. Note RAI denote risk aversion index

The low figure of only 21.4% being risk preferring in earthen pond system as indicated in Figure 3 is expected since majority of the respondents lack access to credit and committed less investment into the enterprise. However, Although Arthur *et al.* (2009) and Nmadu *et al.* (2012) opined that risk attitudes could only be explained by multifaceted factors such as socioeconomic characteristics, environmental, production, cultural and psychological factors.

Figure 4 indicates fish farmers' risk attitudes by assessing their own willingness to accept risks from 0 % (extremely risk averse) to 100 % (extremely risk seeking).

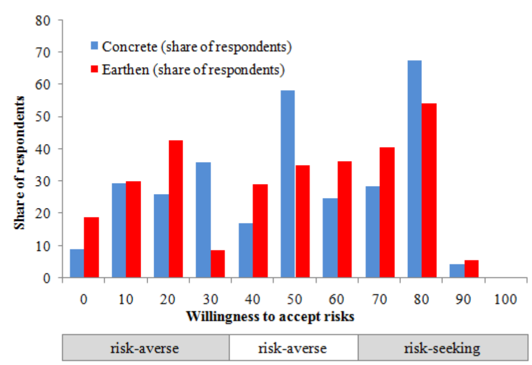

Figure 4: Indicates fish farmers' risk attitudes by assessing their own willingness to accept risks

The result is comparable with findings of Schaper *et al.* (2012) and Theuvsen (2012). Therefore, the exposure of farms to risks can be very diverse, depending on farmers' risk attitudes (Faff *et al.*, 2008; Lucius, 2009; Schaper *et al.*, 2012).

The economic returns (EC) variability results in the two-fishpond systems as well as the pooled data indicated that the earthen pond system exhibited the largest relative EC variability between the two segments studied with CV of 21.75 % (Table 2).

Table 2: Variability in economic returns of fish farming systems per 1000 fingerlings

Systems	Mean cost in Naira	Covariance within the system (%)
Concrete	220,479 ± 8,549	3.88
Earthen	198,650 ± 43,206	21.75
Pooled	207,956 ± 14,428	6.94

Naira, average ₦195 = 1 US Dollar during the survey

The EC in concrete pond system was largely stable with CV of 3.88 %. Why was the EC more variable in earthen pond than return for concrete pond system? Earthen pond system face a greater exposure to low market prices than concrete farmers as most of the ponds are rural and peri-urban which imply that they are located far away from urban markets. Hence, intermediaries who bought from them do so at lower prices.

Table 3 presents the results from a Cobb-Douglas specification disaggregated into concrete, earthen and pooled data for the 277 respondents. The risk preference variables were included in a production function using production data from the fish farmers to define the stated preferences in equation (1) in line with studies of Eggert and Lokina (2007). Hence, of the coefficients on, for instance, the risk-averse and risk-neutral dummies should be interpreted as the differences with regards to the base group, which includes pond size, water, feed, drug, family labour, hired labour, and are risk seeking. The adjusted coefficient of determination (R^{-2}) for each regression signifies that the variables considered jointly explain significant influence on the risk status of the respondents. This is an indication that all or some of the slope coefficients are significantly different from zero. The F-tests result showed that the model was statistically significant at 1.0 % level. It therefore means that the model is capable of showing and explaining the determinants of risk status of the fish farmers. This indication is also confirmed by the Durbin Watson statistic of 2.06 and 1.98 for concrete and earthen fish farmers respectively which is similar to the quantity obtained by Ayinde *et al.* (2008) but quite higher than values obtained by Zepeda (1990).

The risk bearing capacity of the fish farmers can be explained by their socio-economic characteristics in respect of each group. The results of the estimates of the explanatory variables in Table 3 revealed that that the set of significant explanatory variables and their signs vary across the concrete and earthen systems. The coefficients for pond size, drug and family labour were statistically significant for concrete fish farmers but with different signs and levels of significance. While pond size, water, feed, family and hired labour were statistically significant for earthen fish farmers but also with different signs and levels of significance. It is pertinent to note that coefficients of variables that are positive leads to substantial fish harvest, while the contrary applies for the negative coefficients.

The result in Table 4 showed the diagnostic characteristics for concrete, earthen and pooled respondents' data. The likelihood ratio (LR) exceeds the critical chi-square values at $p<0.01$ level of significance. The log likelihood values represent the value that maximizes the joint densities in the estimated model. This showed that the predictors' regression coefficient considered jointly exert a significant influence on the risk status of the respondents. This is an indication that all or some of the slope coefficients are significantly different from zero. It therefore means that the model is capable of showing and explaining the determinants of risk status of the respondents. This indication is also confirmed by the Pseudo R^2 values for the three segments which are in tandem to the values obtained by Zepeda (1990), Nmadu *et al.* (2012) and Abdulrahman *et al.* (2018).

Table 3: Cobb–Douglas production function of fish farming systems per 1000 juveniles

Variables	Concrete pond		Earthen Pond		Pooled Data	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Constant	0.900	0.008	-1.256	0.000	-1.202	0.007
Log pond size	0.006	0.108	0.299	0.065	0.004	0.542
Log water	-0.672	0.000	0.105	0.098	0.238	0.003
Log feed	0.533	0.000	-0.221	0.020	0.497	0.000
Log drug	0.007	0.326	0.098	0.207	-1.0E-5	0.729
Log family labour	-0.061	0.199	0.494	0.000	0.109	0.094
Log hired labour	0.480	0.000	0.254	0.043	0.187	0.011
Risk averse	-0.295	0.022	-0.143	0.019	-0.121	0.075
Risk neutral	- 0.159	0.058	-0.201	0.085	-0.233	0.054
Observation	123		154		277	
R^{-2}	0.431		0.370		0.317	
F-value	21.0		15.6		13.9	
Durbin-Watson	2.06		1.98		1.97	

Table 4: Maximum likelihood estimates of the variables determining fish farming risk status based on multinomial logit regression

Variables	Concrete pond users (n=123)			Earthen pond users (n=154)			Pooled data (n=277)		
	Risk neutral	Risk seeking	Risk aversion	Risk neutral	Risk seeking	Risk aversion	Risk neutral	Risk seeking	Risk aversion
	β	β	B	β	β	B	β	B	B
Constant	0.100 (0.043)	0.261 (0.006)	0.094 (0.069)	0.043 (0.117)	0.216 (0.007)	0.005 (0.273)	0.000 (0.309)	1.008 (0.133)	0.009 (0.195)
Age	0.089 (0.204)	-0.005 (0.108)	0.065 (0.209)	0.321 (0.069)	-0.122 (0.078)	-0.406 (0.005)	-0.206 (0.104)	0.003 (0.189)	-0.238 (0.082)
Experience	-1.8E-5 (0.107)	0.175 (0.046)	-0.142 (0.095)	-0.087 (0.110)	-0.009 (0.105)	0.032 (0.321)	-0.004 (0.553)	1.8E-5 0.287	1.2E-7 (0.679)
Education	-0.277 (0.004)	0.390 (0.000)	0.219 (0.000)	-0.240 (0.004)	0.432 (0.005)	-0.096 (0.095)	-0.783 (0.074)	0.065 (0.074)	-0.079 (0.016)
Household size	3.1E-4 (0.108)	0.245 (0.165)	-0.262 (0.008)	0.076 (0.007)	0.406 (0.000)	-0.301 (0.006)	0.059 (0.321)	0.109 (0.084)	-0.005 (0.099)
Pond size	-0.009 (0.110)	1.0E-6 (0.003)	2.9E-7 (0.322)	-0.001 (0.299)	0.253 (0.005)	0.006 (0.622)	3.3E-5 (0.500)	0.066 (0.790)	1.6E-4 (0.333)
Cooperative	-0.290 (0.053)	-0.184 (0.007)	-0.100 (0.084)	-1.2E-4 (0.095)	0.207 (0.009)	-0.098 0.065)	0.006 (0.211)	0.143 (0.062)	-0.177 (0.008)
Investment	0.431 (0.000)	0.406) (0.000)	-0.283 (0.029)	-0.288 (0.073)	0.195 (0.066)	-0.105 (0.097)	-0.206 (0.087)	0.085 (0.091)	-0.521 (0.006)
Hired labour	0.277 (0.005)	0.246 (0.000)	0.064 (0.082)	0.072 (0.091)	0.068 (0.007)	-0.200 (0.006)	-0.079 (0.086)	0.200 (0.002)	-0.006 (0.009)
Fishery status	0.206 (0.042)	-4.7E-4 (0.206)	-0.009 (0.015)	1.7E-7 (0.406)	1.3E-5 (0.209)	0.002 (0.807)	1.5E-6 (0.309)	0.003 (0.490)	1.2E-7 0.299)
Predictions (%)	37.09	42.62	20.29	41.76	3.74	54.50	35.32	15.66	49.02
Predictions (%)	51.36			43.80			37.54		
LR	154.30			125.92			91.06		
LLR	-145.70			-113.06			-87.54		
Pseudo R^2	0.472			0.359			0.368		

note: β stood for coefficient, figures in parenthesis denote p-value

Zepeda (1990) had indicated that a ratio of 0.25 represents a good fit for multinomial Logit model. The models fitted for each sector (paddled, motorized and pooled) predicted by reasonable percentage accurately risk neutrality, risk preference and risk aversion and the overall percentage predictions makes the estimates obtained good enough for further analysis.

The results of the maximum likelihood estimates (MLE) of the explanatory variables in Table 4 showed that the factors that influence risk among concrete pond system respondents showed slight variation from those influencing earthen one and where it does, not by the same magnitude and direction. For instance, the coefficient for education, household size, total investment pilfering and hired labour were statistically significant for both groups but with different signs and levels of significance.

The result of concrete system showed that the probability of risk neutrality is increased by cooperative society, investment, hired labour and fishery status, and education reduced risk neutrality while the probability of risk seeking in concrete system is increased virtually by all the variables fitted except age and household size. On the other hand, age, education, cooperative and total investment increased risk neutrality in earthen pond system and education, cooperative and total investment reduced risk neutrality. However virtually all the variables fitted in earthen pond system except fishery status increased either risk seeking (education, household size, pond size, total investment, cooperative and hired labour) or reduced it (age and experience).

The implications of increased neutrality by cooperative society showed that these categories of respondents were either not receptive or active in cooperative membership which *sine qua non* to increased neutrality in total investment and ability to hire labour. The increased neutrality in total investment may debar them from imbibing innovations and production technology as well as hired labour that could enable them to procure feeds, improve production technology and acquire more technical know how to deal with risk linked with huge investment associated with concrete pond system. The probability of seeking risk in concrete system is increased virtually by all the variables fitted expect age and household size. Summarily, this demonstrated that these categories of concrete pond users explore their experience and education to utilize the credit and investment acquired from either cooperative society, personal savings or plough back the profit. This is in line with *a priori* expectation as increased risk seeking in these variables assists the respondents to accumulate capital and increased assets to reduce their poverty level.

On the contrary, age, household size and hired labour increased risk neutrality in earthen pond system. This implies that old age and large household size weighs down the respondents to either reduce risk neutrality or increase their attempt in taking risk. However, the result revealed that education, cooperative and total investment tends to reduce their risk neutrality in earthen pond system. This is expected as investment in education and cooperative society enable earthen pond users to acquire better and improved input and equipments to increase fish harvest.

Risk seekers in earthen pond system have education, household size, pond size, cooperative society and hired labour positive, which signify that increase in the coefficients of these variables will lead to the ability to seek risk. It can be concluded that complexity in socio-economic characteristics, environment, production, cultural and psychological factors are the cornerstone to risk attitude of these respondents.

Table 5 showed the estimates of marginal effects (ME) of the variables, which give further incite of the estimate with respect to each risk determinants. The ME values further strengthen the inferences obtained from the parameter estimates in the multinomial logistic model. Literarily, the marginal effects from the model measured the expected change in probability of a risk preference being made with respect to a unit change in an independent variable.

The results of elasticity of variables in Table 6 showed that only hired labour is elastic with respect to risk neutrality in concrete fish

Table 5: Marginal effects (*dy/dx*) of the variables determining fish farming risk status

Variables	Concrete Pond Users (n=123)			Earthen Pond Users (n=154)			Pooled Data (n=277)		
	Risk neutral	Risk seeking	Risk aversion	Risk neutral	Risk seeking	Risk aversion	Risk neutral	Risk seeking	Risk aversion
	dy/dx	*dy/dx*	*dy/dx*	*dy/dx*	*dy/dx*	*dy/dx*	*dy/dx*	*dy/dx*	*dy/dx*
Experience	-0.3007	0.234	-0.097	-0.264	-0.199	0.037)	-0.078	1.1E-05	1.5E-07
Education	-0.053	0.294	0.058	-0.400	0.272	-0.253	-0.402	0.119	-0.065
Household size	1.7E-4	0.063	-0.245	0.008	0.329	-0.211	0.164	0.178	-0.117
Pond size	-0.095	1.3E-06	1.4E-5	-0.065	0.207	0.102	1.7E-04	0.132	1.0E-05
Cooperative	-0.190	-0.108	-0.095	-1.5E-04	0.240	-0.086	0.108	0.143	-0.206
Investment	0.603	0.242	-0.097	-0.198	0.187	-0.128	-0.243	0.199	-0.075
Hired labour	0.200	0.174	0.106	0.099	0.105	-0.186	-0.202	0.173	-0.241

Table 6: Elasticity estimates (ε_i) of the variables determining fish farming risk status

Variables	Concrete Pond Users (n=123)			Earthen Pond Users (n=154)			Pooled Data (n=277)		
	Risk neutral	Risk seeking	risk aversion	Risk neutral	Risk seeking	risk aversion	Risk neutral	Risk seeking	risk aversion
	εi	**εi**	**εi**	**εi**	**εi**	**εi**	**εi**	**εi**	**εi**
Experience	-0.974	0.054	-0.007	-0.208	-0.172	0.309	-0.208	0.643	0.590
Education	-0.243	1.003	0.285	-0.271	0.209	-0.175	-0.302	0.119	-0.230
Household size	0.006	0.084	-0.027	0.053	0.076	-0.353	0.185	0.107	-0.086
Pond size	-0.248	1.532	0.208	-0.421	0.200	0.109	0.099	0.102	0.229
Cooperative	-0.238	-0.164	-0.236	-0.421	0.193	-0.106	0.211	0.408	-0.231
Investment	0.104	2.182	-1.007	-0.932	1.005	-0.965	-1.053	1.007	-1.002
Hired labour	1.009	2.432	1.007	0.954	1.000	-0.743	-0.564	1.005	-0.886

farming while education, pond size, investment and hired labour are positively elastic with respect to concrete pond system. However, in earthen pond system only investment and hired labour are positively elastic. This result on marginal effects and elasticity are comparable with findings of Nmadu *et al.* (2012).

Figure 5 showed the empirical cumulative distribution functions (CDFs) for economic returns in concrete and earthen pond systems using kernel density estimation. The result found higher variability in economic returns for concrete fish farm than for earthen system. The kernel CDFs showed that concrete fish farm system first degree stochastic dominates the earthen system and pooled data, since at every possible probability level the value of economic returns from concrete pond system is greater than that from earthen one. The finding is in line with studies of Kyaw and Routray (2006), Flatten *et al.* (2008), Oladimeji *et al.* (2014; 2015).

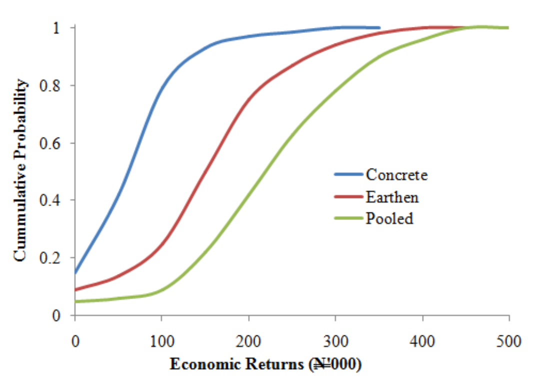

Figure 5: Cumulative Distribution Functions for economic returns in concrete and earthen pond systems using Kernel Density Estimation

Conclusion: Sieving the data of fish farming into concrete and earthen systems, the study finds that the two systems' exhibit different degrees of the risk exposure depending on fish farmers' risk attitudes. The bulk of concrete pond users were risk preferring while majority of earthen pond users belong to risk neutral. The factors that influence risk among concrete pond system respondents showed slight variation from those influencing earthen one and where it does, not by the same magnitude and direction. The coefficient for education, household size, total investment and hired labour were statistically significant for both groups but with different signs and levels of significance. The economic returns variability results revealed that earthen pond system exhibited the largest relative economic return variability between the two segments studied while the economic return in concrete pond system was largely stable. If these results hold true in other fish farming systems with similar socioeconomic variables, production technology and environments and to some extent cultural and psychological variables, it would be concluded that the determinants of fish farmers risk status differ considerably between concrete and earthen pond groups. Further, fish farmers needs to be sensitized through seminars, workshops and trainings in seeking risk by extension personnel in collaboration with agricultural insurance firms, this will go a long way in improving fish production among respondents.

ACKNOWLEDGEMENTS

We thanked the staff and students of the Department of Agricultural Economics, Ahmadu Bello University, Zaria, Nigeria, not mentioned in the manuscript that assisted in data collection for their efforts, numerous authors of articles used for their various contributions and anonymous reviewers for their contributions that help to improve the quality of the manuscript. We also thank the Animal Research International Editorial Board for granting us the opportunity to present our findings to the world at large.

REFERENCES

ABDULRAHMAN, S., OLADIMEJI, Y. U., ABDULLAHI, M. Y., BINUYO, G. and ABDULLAHI, M. M. (2018). Analysis of farmers' choice among alternative rice output markets in Kano State, Nigeria. *Journal of Agricultural Economics, Extension and Social Sciences,* 1(1): 25 – 31.

ARTHUR, J. R., BONDAD-REANTASO, M. G., MARNIE L. CAMPBELL, M. L., MICHAEL J. PHILLIPS, M. J. and SUBASINGHE, R. P. (2009). Understanding and applying risk analysis in aquaculture a manual for decision-makers. *FAO Fisheries and Aquaculture Technical Paper*, 519(1): 1 – 128.

AYINDE, O. E., OMOTESHO, O. A. and ADEWUMI, M. O. (2008). Risk attitudes and management strategies of small-scale crop producer in Kwara State, Nigeria: a ranking approach. *African Journal of Business Management,* 2(12): 217 – 221.

BABALOLA, D. A. (2014). Risk preferences and coping strategies among poultry farmers in Abeokuta metropolis, Nigeria. *Global Journal of Science Frontier Research*, 14(5): 1 – 9.

DEATON, A. (1997). *The Analysis of Household Survey: A Microeconomic Development Policy*. John Hopkins University Press, Baltimore, USA.

EGGERT, H. and LOKINA, R. B. (2007). Small-scale fishermen and risk preferences. *Marine Resource Economics*, 22(1): 49 – 67.

EGGERT, H. and TVETERAS, R. (2004). Stochastic production and heterogeneous risk preferences: commercial fishers' gear choices. *American Journal of Agricultural Economics*, 86(1): 199 – 212.

FAFF, R., MULINO, D. and CHAI, D. (2008). On the linkage between financial risk tolerance and risk aversion. *Journal of Financial Research, 31(1): 1 – 23.*

FLATEN, O., LIEN, G. and TVETERÅS, R. (2008). A comparison of risk exposure in aquaculture and agricultural businesses. Pages 1 – 5. *In: 12th Congress of the European Association of Agricultural Economists* (EAAE), 2008.

HARDAKER, J. B., HUIRNE, R. B. M., ANDERSON, J. R. and LIEN, G. (2004). *Coping with Risk in Agriculture.* 2nd Edition, CABI Publishing, Wallingford.

HUFFMAN, S. L., HARIKA, R. K., EILANDER, A. and OSENDARP, S. J. (2011). Essential fats: how do they affect growth and development of infants and young children in developing countries? A literature review. Maternal and child Nutrition, 7: 44 – 65.

KRIS-ETHERTON, P. M., HARRIS, W. S. and APPEL, L. J. (2002). Fish consumption, fish oil, omega-3 fatty acids, and cardiovascular disease. Circulation, 106(21): 2747 – 2757.

KYAW, D. and ROUTRAY, J. K. (2006). Gender and rural poverty in Myanmar. a micro level study in the dry zone. *Journal of Agriculture and Rural Development in the Tropics and Sub Tropics,* 107(2): 103 – 114.

LUCIUS, O. (2009). Recording the risk appetite of customers - do regulatory requirements help? Pages 29 – 42. *In:* EVERLING, O. and MÜLLER, M. (Eds.). *Risk Profiling of Investors: Analyze Customer Profiles Aptly and Use Them in the Consultation*. Bank Verlag, Cologne, Germany.

MCFADDEN, D. (1974). Conditional logit analysis of qualitative choice behavior. Pages 105 – 142. *In:* ZAREMBKA, P. (Ed.). *Frontier in Econometrics.* Academic Press, New York.

NMADU, J. N., EZE, G. P. and JIRGI, A. J. (2012). Determinants of risk status of small scale farmers in Niger State, Nigeria. *British Journal of Economics, Management and Trade*, 2(2): 92 – 108.

OLADIMEJI, Y. U., ABDULSALAM, Z., DAMISA, M. A., AJAO, A. M. and SIDI, A. G. (2014). Empirical analysis of artisanal fishery practices and constraints: a synergy to poverty alleviation and sustainable fishery development in north central, Nigeria. *Ethiopia Journal of Applied Science and Technology,* 4(2): 85 – 102.

OLADIMEJI, Y. U., ABDULSALAM, Z. and ABDULLAHI, A. N. (2015). Determinants of participation of rural farm households in non-farm activities in Kwara state, Nigeria: a paradigm of poverty alleviation. *Ethiopian Journal of Environmental Studies and Management,* 8(6): 635 – 649.

OLADIMEJI, Y. U., ABDULSALAM, Z. and AYANDOTUN, B. W. (2016). Rural household fuel consumption and energy crisis: a synopsis of poverty trend in north central Nigeria. *Ethiopia Journal of Applied Science and Technology*, 7(1): 59 – 76.

OLADIMEJI, Y. U., ABDULSALAM, Z., MANI, J. R., AJAO, A. M. and GALADIMA, S. A. (2017). Profit efficiency of concrete and earthen pond system in Kwara State, Nigeria: a path towards protein self-sufficiency in fish farming. *Nigerian Journal of Fisheries and Aquaculture*, 5(2): 104 – 113.

OLADIMEJI, Y. U., ADEPOJU, S. A., YUSUF, H. O. and YUSUF, S. (2018). Energy efficiency improvement in fish production systems in Oyo State, Nigeria: a path towards sustainable protein supply. *Nigerian Journal of Agricultural Extension,* 19(1): 71 – 82.

ROY, A. D. (1952). Safety first and the holding of assets. *Econometrica*, 20(3): 431 – 449.

SALIMONU, K. K. and FALUSI, A. O. (2007). Risk preferences and resource allocation differentials of food crop farmers. *Journal of Rural Economics and Development*, 16(1): 1 – 12.

SCHAPER, C., BRONSEMA, H. and THEUVSEN, L. (2012). Risk management in agriculture: operational risk management in agriculture - an empirical analysis in Saxony, Saxony-Anhalt, Thuringia and Mecklenburg-Vorpommern. Publication Series of the State Office for the

Environment, Agriculture and Geology, Germany.

SEKAR, I. and RAMASAMY, C. (2001). Risk and resource analysis of rainfed tanks in South India. *Journal of Social and Economic Development*, 3(2): 208 – 215.

THEUVSEN, L. (2012). Risk management in agriculture: focus on risk assessment and risk-bearing capacity. Pages 23 – 31. *In:* Doluschitz, R. (Ed.). *Proceeding to the Workshop: Transformation of Entrepreneurship in Agriculture - New Challenges for Farmers, Associations, Upstream and Downstream Partners from the Value Chain and for Science.* April 27, 2012, University of Hohenheim, Stuttgart.

ZEPEDA, L. (1990). Adoption of capital versus management intensive technologies. *Canadian Journal of Agricultural Economics*, 38(3): 457 – 469.