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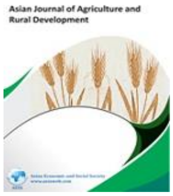

SOCIO-ECONOMIC STATUS AND LEVEL OF BIOSECURITY PRACTICE OF CATFISH FARMERS IN DELTA NORTH AGRICULTURAL ZONE, DELTA STATE, NIGERIA

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ABSTRACT

The socio-economic status and level of practice of biosecurity measures amongst catfish farmers in Delta North Agricultural Zone of Delta State were assessed. Data was collected randomly from 115 catfish farmers by oral interview and administration of structured questionnaires. Descriptive statistics and multiple linear regression analysis were used to analyze data collected. Results obtained show that catfish farmers had a mean of 45 years, dominated by males with 54.8 % having secondary education and 7.8 years experience in fish farming. The coefficients for stocking density, source of fish seed, organic inclusions, workers shower, access restrictions, a record of fish disease and pathogen management were highly significant ($P<0.05$). It implies that these variables are important factors influencing the practice of biosecurity measures in the study area. A poor level of practice of biosecurity was observed with a large number of negative coefficients of independent variables, implying that increases in the magnitude of these variables may lead to a reduction in the level of biosecurity practice amongst catfish farmers in the area. This study also observed that the practice of biosecurity measures was not an important issue among catfish farmers. Guidelines supported by appropriate legislation is needed to enforce practice and compliance of biosecurity practice.

Contribution/ Originality
This study has shown that the level of biosecurity practice of catfish farmers in Delta North Agricultural Zone of Nigeria is poor. Though the farmers understand the importance of producing healthy aquaculture fish, minimal biosecurity practice was carried out. There is a need for a specific legal biosecurity framework for the practice of aquaculture in the area to forestall any future incidence of disease outbreaks.

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1. INTRODUCTION

Fish is important to humans and animals as food, source of protein and for the generation of income by man. Intensive fish culture in the tropics has introduced stress due to overcrowding, poor water quality and general lack of knowledge of fish farming occasioned by the entry of unskilled personnel into fish culture practices (Pulkkinen *et al.*, 2010). Stress has been reported to be a major cause of disease outbreaks in fish ponds (Gabriel and Akinrotimi, 2011; Raman *et al.*, 2013). Fish diseases of protozoal (Martins *et al.*, 2015, Okoye *et al.*, 2016, Rakesh *et al.*, 2018, Ogbu *et al.*, 2019), helminth (Onyedineke *et al.*, 2010, Onyishi and Aguzie, 2018), bacterial (Sudheesh *et al.*, 2012, Adeyemo, 2013, Wamala *et al.*, 2018, Kousar *et al.*, 2019), fungal (Melaku *et al.*, 2017, Idowu *et al.*, 2017, Patel *et al.*, 2018) and viral (Ozturk and Attinok, 2014) origins have been reported in many tropical fish ponds. Management of fish diseases has, therefore, become an issue of great concern, particularly to rural fish farmers with little or no skills in fish farming. Outbreaks of fish diseases have resulted in fish kills and economic losses, cumulating in reduced fish production (Okaeme *et al.*, 1987; Hossain *et al.*, 2011; Pridgeon and Klesius, 2012; Oladele *et al.*, 2015; Kousar *et al.*, 2019). The ability to curtail, contain and eradicate diseases of fish when they occur will depend on several factors bordering on biosecurity measures put in place and the extent of compliance with these measures.

Biosecurity has been defined as a strategic and integrated approach for the analyses and management of relevant health and environmental risks to human, animal and plant lives (Hawkes and Ruel, 2006). This approach is based on legal and regulatory frameworks for the protection of life forms. It has become a necessity to protect cultured fish stock from possible negative impacts resulting from the introduction, spread of animal diseases and management risks in aquaculture production facilities (Pena *et al.*, 2018). With biosecurity measures in place, the risks to health and life can be prevented, controlled, or eradicated as well as reduce the economic impacts of disease (Pena *et al.*, 2018). In aquaculture, biosecurity consists of practices that minimize the risk of introducing and spreading the infectious disease to animals, susceptible species, and other cultural sites (Banrie, 2013).

There is less information on the legal framework regarding the biosecurity of fish farms in the study area. Legislation on biosecurity of fish farms is either not available or non-existence. The entrance of unskilled personnel into the aquaculture industry due to unemployment and food fish security issues has prompted the need to assess the practice of biosecurity amongst catfish farmers in Delta North Agricultural Zone of Delta State, Nigeria, to recommend appropriate measures for improved fish health and prevention of disease outbreak.

2. MATERIALS AND METHODS

2.1. Study area

Delta State, located in Niger Delta, Southern Nigeria consists of three agricultural zones by the Niger Delta State Agricultural Development Programme (DTADP), namely: Delta North, Delta Central and Delta South Agricultural Zones. Delta State is situated between longitude 5º00' and 6º 45' East and latitude 5º00' and 6º30' North (Figure 1). Delta North is made up of nine Local Government Areas (LGAs): Oshimili South, Oshimili North, Aniocha South, Aniocha North, Ndokwa East, Ndokwa West, Ika South, Ika North East and Ukwuani. The population of Delta North Agricultural zone was 1,236,840 persons by the National Population Commission (2006). The inhabitants of the area have diverse occupations such as farming, fishing, trading and secular jobs.

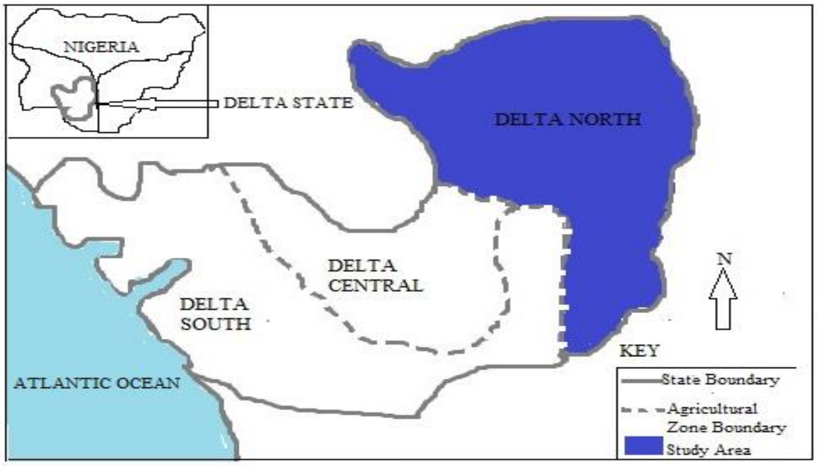

Figure 1: The study area, Delta North, Nigeria

2.2. Selection of fish farms and locations

A multi-stage sampling procedure was used to draw samples for the study. In the first stage, eight LGAs out of the nine in Delta North Agricultural Zone were purposively selected based on the presence of water bodies like River Niger, River Adofi, and some streams which encourage fish farming activities in the areas and also to the presence of fish farms in the areas. In the second stage, a simple random sampling technique was used to select sixteen fish farmers from the eight LGAs amounting to one hundred and twenty-eight catfish farmers. The sixteen catfish farmers were selected purposively from the different communities in the LGAs based on the presence of fish farms in the areas. It was discovered that not all the catfish farmers in the area were registered with the State Department of Fisheries. The study, therefore, involved both registered and un-registered fish farmers. About 0.01% of the population of the area of study were catfish farmers.

2.3. Interview and visits to fish farms

Primary data for the study was obtained from fish farmers using a structured questionnaire. The fish farmers were also interviewed and assisted in ascertaining that the questionnaire was filled correctly. Out of 128 catfish farmers interviewed, questionnaires from 115 respondents were used due to unresponsiveness and inadequate information supplied by the farmers. Information of fish farm activities for the last one year obtained were on: pond preparation - PP, source of water supply - SW; source of fry/fingerlings - SF, disinfection of facility - DF, quarantine of fry/fingerlings before stocking - QF , fingerling disinfection - FD, correct feeding practices - CF, type of feed (conventional or non-conventional) - TF, feed storage methods - FS, probiotics application to feed - PA, good husbandry practices - GH, water quality management - WQ, organic inclusions into pond other than fish feed - OI, proper fish handling - HF, routine observations - RO, access restrictions to visits - AR, provision of mobile foot bath - FB, biosecurity awareness - BA, hand washing - HW, provision of shower for workers to bath - SW, environmental management/ disposal of effluent - EM, working with veterinary personnel - WV, professional pathogen management - PM, notify government agency of any outbreak - NG, stocking densities - SD, history of vaccination- HV, disposal of dead fish - DD, record keeping of disease - RD, practice of integrated farming - IF, wildlife visits to farm (e.g. rodents, frogs/toads, snails, snakes) - WV and fencing of facility- FN. These gave rise to 31 independent biosecurity variables, including control variables.

In contrast, the level of biosecurity practice is the dependent variable. The 31 biosecurity variables were adapted to suit the area of study and the Nigerian environment from the works of Banrie (2013) and Fasanmi *et al.* (2016). Other information obtained was on socio-economic variables such as gender, age, marital status, family size, level of education, experience on the job, level of inputs, level of output and other sources of income. The survey was conducted between January and April 2019.

2.4. Statistical analysis

Descriptive analysis was used to describe the socio-economic variables (Objective 1). The method was used to describe the variables of gender, age, marital status, family size, level of education, fishing experience, input, output and other sources of income. Multiple regression analysis was used to determine the variable factors affecting the level of biosecurity practice of catfish farmers in the area of study (Objective 2). The farmers' expression on biosecurity variables were dichotomous because fish farmers were to answer whether or not they practiced biosecurity measures in their fish farms. Dichotomous data were subjected to logistic multiple regression model by first stating the regression model implicitly in an equation form as:

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, \dots \dots . X_6, e)$$

Where:
Y = dependent variable (level of biosecurity practice - %)
X = independent variables
e = Random Error
(Udoh and Nyienakuna, 2008).

Three functional forms of the model, linear, semi-log, and double-log functions, as used by Almeida *et al*. (2001), were used for the analysis. The one with the best fit was used as the lead function based on having the highest value of the coefficient of multiple determination, the highest number of significant variables and conformity to a priori expectations. The level of biosecurity practice was inputted as the dependent variable while the variables were taken as the independent variables with the practice of biosecurity measure (Yes) and the non-practice of biosecurity measures (No) recoded as 0 and 1 respectively. The self-rated level of biosecurity practices by the fish farmers was scored at four levels (Objective 3). The scoring method used was based on the modified qualitative scoring by Pagani *et al.* (2008). The 31 variables of biosecurity measures were scored as follows:

Level 1: non to very poor practice, 0 - 25%
Level 2: very poor to poor practice, 26 - 50%
Level 3: poor to good practice, 51 -75%
Level 4: good to very good practice, 76 - 100%

Any variable to be scored as 'being practiced,' has a score of "4", and for statistical analysis, all scores below "4" that is (1-3) were recorded to 0, while scores greater or equal to "4" was assigned a score of 1.

3. RESULTS AND DISCUSSION

The socio-economic characteristics of catfish farmers in the study area are presented in Table 1. Out of 115 catfish farmers, 79.1 % were males, while 20.9 % were females. The domination of men in fisheries activities has been reported (Brummett *et al*., 2010; Olaoye *et al*., 2013). Inoni *et al.* (2017) also reported that men were more abundant in catfish farming since women have limited access to productive resources, external inputs, and information. More of the fish farmers were between 41 and 50 years of age. The average age of fish farmers was 45 years, with the youngest being 28 years and the oldest 72 years with 54.8 % having a secondary level of education. It confirms the findings of Ayotunde and Oniah (2012), which reported that a large number of fisherfolks were educated, and this portends a better future for catfish production.

Table 1: Socio-economic characteristics of catfish farmers

Variables	Frequency	Percentage (%)	Mean (Mode)
Gender			
Male	91	79.1	
Female	24	20.9	
Age			
21-30	10	8.7	
31-40	26	22.6	
41-50	42	36.5	45
51-60	30	26.1	
61 and above	7	6.1	
Marital status			
Single	4	3.9	
Married	104	90.4	Married
Widowed	6	5.2	
Divorce	1	0.9	
Size of family			
0-4	28	24.3	
5-9	84	73.0	6 persons
≥ 10	3	2.6	
Level of education			
Non-formal	0	0.0	
Primary	11	9.6	
Secondary	63	54.8	Secondary
Tertiary	41	35.7	
Job experience			
0-5	36	31.3	
6-10	53	46.1	7.8 years
11-15	16	13.9	
16-20	1	0.9	
≥ 21	9	7.8	
Input level (₦)			
10, 000 - 50,000	28	24.3	
60,000 - 100,000	75	65.2	₦83,362.33
110,000 -150,000	9	7.8	
160,000 - 200,000	3	2.6	
Output level (₦)			
10, 000 - 50,000	34	29.6	
60,000 - 100,000	16	13.9	
110,000 -150,000	62	53.9	₦132,476.19
160,000 - 200,000	3	2.6	
Other sources of income			
No other source	0	0.0	
Crop farming	63	54.8	Crop farming
Trading	17	14.8	
Civil service	45	39.1	

Source: Field survey, 2019
Note: ₦370.00 to $1

The respondents were found to be within the productive and economic active age. According to earlier reports, this active age is beneficial for the improvement of livelihood for families (Okeowo *et al.*, 2015). The level of education was observed to impact positively on the respondents, as shown in the level of biosecurity awareness. The high level of education is expected to contribute significantly to decision making by the fish farmers, which becomes an advantage in terms of achieving sustainability in aquaculture. A major percentage, 90.4 % of the fish farmers, were married. The majority of fish farmers have been reported to be married and, by this, have a cherished level of responsibility (Oladoja *et al*., 2008). This shows that the marriage institution is still appreciated as a sign of the economic responsibilities of the respondents (Ayotunde and Oniah, 2012). An average family size of 6 was observed in this study, thus indicating that family members may be involved in fish farming activities to reduce the cost of labour and increase productivity. Fifty-three (46.1 %) of the respondent had between 6 and 10 years of experience on the job with a mean of 7.8 years. This number of years of experience on the job is beneficial for fish farming in the area of study, since farmers with less number of years of experience may be discouraged when they encounter many risks in the early days of fish farming business (Olaoye *et al*., 2013). The respondents with more experience are also more likely to be able to forecast the market situation in which they may sell their products at higher prices. The input level shows that 65.2 % expended between N60,000 and N100,000 with a mean of ₦83,362.33 while output in the form of income was ₦132,476.19 with 53.9 % of the farmers earning between ₦110,000 and ₦150,000. Most of the fish farmers (54.8 %) had other sources of income, such as crop farming and poultry. This result is in agreement with earlier findings, which stated that fish farming business is profitable according to the level of investment and variable cost minimization (Adewuyi *et al*., 2010; Kassali *et al*., 2011).

Table 2: Results of multiple regression analysis

Independent variables	Coefficients	± S.E	t-value	P-value
Constant	1.935	0.34	5.695	0.000
Pond preparation	-0.145	0.086	-1.689	0.095
Source of water supply	0.101	0.062	1.626	0.108
Disinfection of facility	-0.032	0.053	-0.599	0.551
Quarantine of fry/fingerlings before stocking	-0.343	0.076	-1.616	0.11
Fingerlings disinfection	-0.187	0.116	0.058	0.954
Stocking densities	0.005	0.087	2.031	0.045*
Source of fish seed (e.g. fingerlings)	0.104	0.051	-4.538	0.000*
Correct feeding practices	-0.102	0.083	-1.231	0.222
Probiotics application to feed	-0.131	0.08	-1.637	0.105
Type of feed (conventional or non-conventional)	-0.049	0.069	-0.714	0.477
Feed storage methods	-0.058	0.074	-0.785	0.435
Organic inclusions into pond other than fish feed	-0.15	0.051	-2.928	0.004*
Good husbandry practices	0.061	0.113	0.536	0.594
Water quality management	-0.08	0.065	-1.23	0.222
Fish handling	-0.376	0.285	-1.317	0.191
Routine observations	-0.079	0.079	-1.004	0.318
Provision of mobile foot bath	0.026	0.079	0.332	0.741
Hand washing	-0.233	0.131	-1.774	0.08
Workers shower	-0.163	0.062	-2.626	0.010*
Access restrictions to visits	-0.171	0.062	-2.735	0.008*
Environmental management/Waste disposal	-0.034	0.067	-0.508	0.613
Work with veterinary officer	-0.012	0.06	-0.203	0.84
Record keeping of disease	-0.211	0.07	-3.027	0.003*
Pathogen management	-0.156	0.062	-2.504	0.014*
Notify government of any outbreaks	-0.128	0.09	-1.428	0.157
History of vaccination	-0.066	0.052	-1.268	0.208
Biosecurity awareness	0.03	0.115	0.257	0.798
Disposal of dead fish	-0.02	0.073	-0.272	0.787
Practice Integrated fish farming	-0.029	0.081	-0.358	0.721

Wildlife visits to farm (e.g. rodents, frogs, snails)	-0.249	0.199	-1.248	0.215
Fencing of farm	0.021	0.055	0.388	0.699

Source: Field survey, 2019
* Significant at P < 0.05

Results show that the model used was a good fit, implying that 63 % of the levels of biosecurity practice resulted from the independent variables. The multiple regression coefficients for stocking density, source of fish seed, organic inclusions, workers shower, access restrictions, the record of fish disease and pathogen management were highly significant (P < 0.05). It implies that these variables are important factors influencing the practice of biosecurity measures in the study area. The coefficients for the source of water supply, stocking density, good husbandry practice, provision of mobile footbath, biosecurity awareness and fencing of the farm were positive, indicating that increases in the magnitude of these variables may bring about increases in the level of biosecurity practice. A large number of negative coefficients of independent variables were observed, implying that increases in the magnitude of these variables may lead to a reduction in the level of biosecurity practice amongst catfish farmers in the area. It calls for a more serious effort in enforcing and monitoring the practice of biosecurity in catfish farms in the area of study, particularly regarding stocking density, source of fish seed, organic inclusions, workers shower, access restrictions, the record of fish disease and pathogen management. Control variables used were inputted as part of the independent variables. The contribution of each factor, including the control variables, was minimal. Hence ruling out any bias in the model used.

The level of biosecurity practice was rated as 2 with scores from 26 -50 % (very poor to poor) in all LGAs (Figure 2). Most of the fish farms visited practiced intensive fish culture; fish was therefore predisposed to diseases due to stress resulting from bad husbandry practices, particularly having to do with organic inclusions to water, which may have led to poor water quality. Poor water quality resulting from incorrect feeding with excess organic waste deposition in water was a major probable predisposing factor in most of the fish farms (Pann, 2009). Optimum fish production has been reported to be dependent on the physical, chemical and biological qualities of water for successful pond management (Bhatnagar and Devi, 2013).

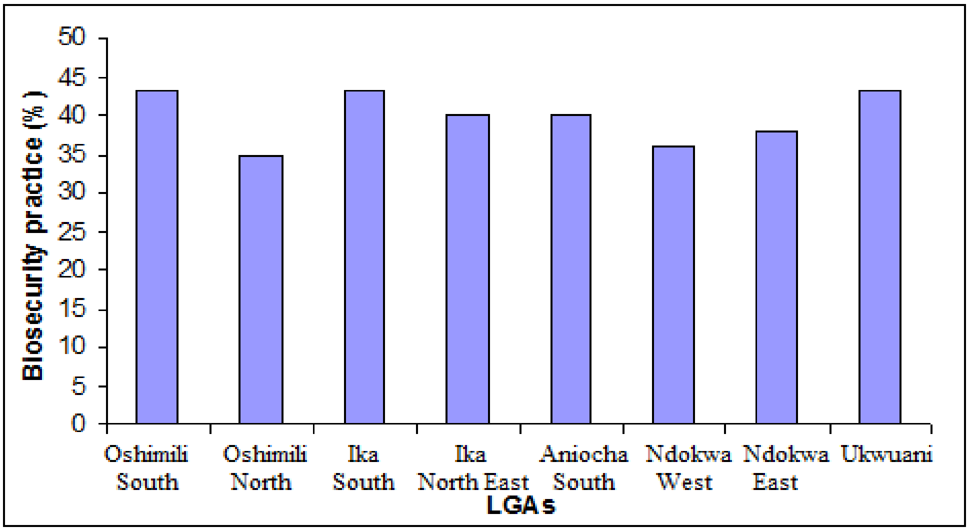

Figure 2: Level of biosecurity practices by catfish farmers in LGAs

This study also observed that the practice of biosecurity measures was not an important issue among catfish farmers. Most of the farmers preferred non-professional option for the treatment of fish diseases. It has been reported that some fish ponds in some of the areas of study are not free of pathogenic agents (Nwabueze, 2012). Improper or insufficient dosage and treatment of fish diseases could lead to the danger of toxicity, which could cause damage to organs and hinder organ functions as well as introducing the risk of bacteria developing resistance (Young, 2003). Although Anetekhai (2013) reported that outbreaks of fish diseases had not been a major concern in Nigeria, the incidence of mortality of fries of about 2 - 4 weeks was observed across the country, with the true cause of the disease not fully known. It shows that there is a need to put biosecurity checks in place and to monitor compliance to forestall any future fish disease outbreaks. D'Andrea (2005) observed that there was no specific legal framework for inland fish farming in Nigeria, apart from the inland fisheries decree of 1992, which had a single provision empowering the Minister in charge of fisheries matters to determine whether the set up of enclosures such as pens and cages should be subject to a license fee. Currently, there is no specific legal definition or framework for the practice of aquaculture in Nigeria.

4. CONCLUSION

A poor level of practice of biosecurity was observed in the study area. Though most of the farmers were aware of the importance of maintaining a healthy fish production system, the practice of biosecurity in the fish farms by catfish farmers was not an important issue in fish production. Proper and professional conduct in the aquaculture industry is a necessity for the management of fish farms to forestall any outbreaks of fish diseases in the area. Also, a legal framework of international standards to regulate and monitor the level of practice of biosecurity amongst catfish farmers in the aquaculture industry should be put in place. It will go a long way to preventing any future consequences of negligence in aquaculture practices in the area of study.

4.1. The implication for sustainable aquaculture development

The poor level of biosecurity practice is not beneficial for the production of healthy fish, particularly in the event of a future disease outbreak. For sustainable aquacultural development, therefore, the practice of biosecurity measures are necessary for catfish farms. Guidelines for these measures are to be formulated and supported by appropriate legislation to ensure compliance. It will improve the production of healthy fish and a healthier environment to enhance food security for humanity.

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