ADAPTIVE STRATEGIES TO CLIMATE CHANGE AMONG FISH FARMERS IN ASARI TORU LOCAL GOVERNMENT AREA, RIVERS STATE, NIGERIA

Okorie, U. G.[*], Okoro, Chukwuma Bede[**] & Osughe, N. J.[*]
[*]Department of Agricultural Extension and Development Studies, University of Port Harcourt, Rivers State Nigeria.
[**]Nigerian Institute of Oceanography and Marine Research Sapele, Out-Station, Delta State, Nigeria
Email of corresponding author: ugochi.okorie@uniport.edu.ng Phone: 08030605458

Abstract
The study focused the adaptive strategies employed by fish farmers in Asari Toru Local Government Area, Rivers State to mitigate climate change. The specific objectives were to: describe the socioeconomic characteristics of the fish farmers, examine the effects of climate change on fish farming, ascertain the adaptive strategies used, and identify the constraints faced in using these strategies. A two-stage sampling technique was used to select 108 fish farmers. Data for the study was collected using a questionnaire and analyzed using descriptive statistical tools such as percentage and mean, while correlation was employed to analyze the hypothesis. The result revealed that the mean age of the fish farmers was 39 years, 53.8% were males with an average household size of 5 persons, 95. 4% were educated with a mean fish farming experience of 10 years and made an average income of ₦ 67,100.54K from fish farming monthly. The mean monthly output was 441.09 kg monthly. The major effect of climate change on fish farming were decreased output (83.3%), and flooding of fishponds (81.5%). the major adaptive strategies used by the respondents were seeking early warning information ($\bar{x}$ =3.26) and construction of fishponds with proper drainage ($\bar{x}$ =3.13). The major constraints faced in using the strategies include inadequate training and technical know-how ($\bar{x}$ =3.39), insufficient funds ($\bar{x}$ =3.36) and not getting information on time ($\bar{x}$ =3.22). It is recommended that extension personnel should be deployed to Asari Toru LGA of River State to meet the training and information needs of the fish farmers.

Key Words: Adaptive strategies, fish farmers and climate change

Introduction

The food production sector faces several challenges in making adequate food and other agro-based materials available to the growing world population. The human population has been projected to increase to nine billion by 2050 (United Nations Department of Economic and Social Affairs, Population Division, 2024). Climate change is a major environmental threat to agricultural production worldwide, with aquaculture being one of the most vulnerable sectors. The unpredictable rainfall, increasing temperature, and erratic weather patterns, is disrupting fisheries and aquaculture (Food and Agriculture Organization FAO, 2021), particularly in third-world countries whose agricultural production largely depends on natural resources (Intergovernmental Panel on Climate Change (IPCC), 2022). Many of the world's population depends on fisheries and aquaculture for food, essential nutrients, and livelihoods. According to Oyebola, *et.al* (2020), Fish farming, also known as aquaculture has gained significant ground in recent years, serving as an alternative for capturing fish due to the increasing demand for seafood, the depletion of wild fish stocks, and environmental degradation.

Aquaculture (fish farming) is one of the fastest-growing subsectors of the animal food production industry in the world. Fish are very high sources of proteins and have great nutritional values. Many developing nations are increasingly adopting aquaculture, including Nigeria whose fish industry was reported to be the 2nd largest in Africa. However, the sustainability of fish farming is threatened by climate change-related risks such as increased fish mortality, water pollution, habitat degradation, and disease outbreaks. The IFAD (2020) posited that climate change would adversely affect livelihood activities, agricultural productivity, incomes of farm households, and food security. Oyebola et al. (2021) assert that fish farming would be

more affected by climate change than other agricultural sub-sectors because flood-prone marshy wastelands are mostly used as fishponds in the producing areas. The World Bank (2021) alludes that change in the global climate is expected to continue beyond this century. Therefore, there is a need for effective adaptive strategies to mitigate these impacts to become imperative for fish farmers in the study area.

The effects of climate change on fish farming are multifaceted, affecting the economic and biological aspects of production (IPCC, 2021). For instance, rising temperatures affect water quality parameters such as pond aeration, pH, and ammonia concentration, which in another way impacts fish growth, reproduction, and survival negatively. Extreme weather events such as floods and droughts (Kim *et al.* 2019), disrupt pond management, destroy infrastructure, and lead to increased production costs. Again, the growth of waterborne diseases and parasites due to fluctuation of water conditions worsens the production risk faced by fish farmers. The ability of the fish farmers to strategically adapt to the changing climate would determine the sustainability livelihood, general wellbeing of the fish farmers and that of the nation at large.

To avert this climate change-induced risk, maintain sustainable livelihood, and meet the daily protein requirement, the fish farmers must adopt adaptive strategies, as adaptation helps in the reduction of vulnerability and exposure to climate change risk (IPCC, 2022; Tun Oo, 2018). Adaptation in fish farming involves both short-term and long-term strategies, including technological interventions, policy-driven initiatives and change of farming methods. Some studies have identified the effects of climate change on aquaculture and adaptive strategies adopted by fish farmers have been identified include seasonal adjustments in stocking and harvesting among others, seeking early warning information, selective breeding for heat-resistant fish species, integrated water management, climate-resilient infrastructure, (Adeleke et al., 2020; Onyeneke *et. al* 2020), but none of the studies looked at the relationship between fish farmers' output and the adaptive strategies employed.

The adaptation strategies used may be a function of some socio-economic factors such as education level, income, access to credit, output level, and extension services. Fish farmers with higher educational qualifications may have better access to information and training, hence, are most likely to adopt climate-smart practices. Similarly, farmers' income play an important part in the ability of the farmers to invest in adaptive technologies such as improved feed formulations, aerators, and water recycling systems. Despite the availability of these adaptation options, fish farmers in Asari-Toru LGA continue to struggle issues of adaptation to climate change. Given the growing concerns about climate change and its effects on fish farming, this study aims to examine the adaptive strategies used by fish farmers in Asari-Toru LGA of Rivers State and the relationship between the output and the adaptive strategies employed with the following specific objectives,

to: describe the socioeconomic characteristics of the fish farmers; examine the perceived effects of climate change on fish farming; ascertain the adaptive strategies used, and identify the constraints faced in using these strategies.

Methodology

The study was carried out in Asari Toru Local Government Area of Rivers State, Nigeria with its headquarters in Buguma Town. The Local Government Area upon creation is made up of (17) Communities namely: Buguma, Abalama, Abiama, Angulama, Atuka, Ido, Ifoko, Illelema, Krakrama, Minama, Okpo, Omekweama, Omekwetariama, Oporoama, Sama, Sangama, Tema. The major occupation of the people of Asari Toru is fishing, though they also farm on cassava, plantain and yam. The population of the study consists of all fish farmers in Asari Toru LGA. A two-stage sampling procedure was used to select respondents for the study. In the first stage 9 communities were randomly selected out of the total number of 17 communities in the study area. In the second stage, 12 fish farmers were selected from each of the communities to give a total of 108 fish farmers in the study area. A questionnaire was used to collect data, which was analyzed using descriptive statistics such as frequency, percentage were used for objectives 1,2 and 3, while objectives 4 and 5 were analyzed using mean with a decision rule of 3.00. The set hypothesis was analyzed using a Pearson correlation.

Results and Discussion

Socio-economic Characteristics of Fish Farmers

A good proportion of fish farmers (50%) were between the ages of 31-40 years, with a mean age of 39 years. This shows that fish farming in the study area is predominantly carried out by young and middle-aged individuals. These people are known to be risk-takers and more open to innovative practices. This result agrees with the findings of Olaoye *et.al*, (2021) who reported that fishers were within their prime and economically active. According to Olutumise, (2023) younger farmers are more risk aversive which can reduce output losses. Hence, having young people makes this sector promising, these farmers could increase output by adopting climate-smart adaptation strategies.

The result in Table 1 also indicated relative gender balance, with 53.8% males and 46.2% females. This contradicts the traditional notion of fish farming being male dominated. Adeoye et.al (2020) reported that males were more involved in fish farming, while the females major in processing. The result suggests increasing female participation in fish farming, which may be a way of cushioning the effects of climate change by vertical diversifying of livelihood. The mean household size is five people, which is considered moderate and can be a source of family labor to meet up with climate change-induced labor scarcity without imposing excessive dependency burdens.

A high percentage (74.5%) of fish farmers had at least secondary education. Education plays an important role in the adoption of new technologies and improved management practices particularly as it affects climate change adaptation. Olaoye *etal.* (2021), had similar result, emphasizing that education enhances productivity and efficiency. The data on fish farming experience shows that 48.2% of the fish farmers had 6-10 years of experience, with an average of 10 years. In other words, the fish farmers were well experienced and are likely to have better management skills and adaptability to climate-induced challenges, leading to higher productivity.

Table 1: Distribution of fish farmers according to their socio-economic characteristics

Variables	Frequency (n=108)	Percentage (%)	Mean
Age			
Below 30	17	15.7	
31-40	54	50.0	**39 years**
41-50	25	23.1	
51-60	9	8.3	
61 and above	3	2.7	
Sex			
Female	50	46.2	
Male	58	53.8	
Household Size			
1-3	35	32.4	
4-6	48	44.4	**5 persons**

7-9	24	22.2	
10 and above	1	0.9	
Educational Level			
Non Formal Education	5	4.6	
Primary education	24	22.2	
Secondary Education	53	49.1	
Tertiary education	27	25.0	
Experience in Fish Farming			
1-5 years	14	12.9	
6-10 years	52	48.2	**10 Years**
11-15 years	35	32.4	
Above 16 years	7	6.5	
Type of Fish Pond			
Earthen Pond	52	48.1	
Concrete	33	30.6	
Tank	17	15.7	
Monthly from Fish Production (₦)			
≤ 20,000	5	4.6.0	
20,001-40,000	19	17.6	
40001-60,000	22	20.3	
60001-80,000	34	31.4	**₦ 67,100.54K**
80,001-100,000	24	22.2	
≥ 100,001	4	3.7	
Average Monthly Production Output(Kg)			
≤ 200	28	25.9	
201-400	24	22.2	
401-600	28	25.9	441.09 Kg

601-800	24	22.2
>800	4	3.7
Contact with Extension		
Never	52	48.1
Rarely	28	25.9
Once a year	15	13.9
Twice per Year	6	5.6
Thrice per Year	7	6.5

Field, Survey, 2024

The earthen pond is the most (48.1%) commonly used method, followed by the concrete pond (30.6%) and tank (15.7%) systems. The use of earthen pond culture may be due to its cost-effectiveness and suitability for various fish species. The result is consonant with findings from Food and Agriculture Organization (FAO, 2020), which indicated that pond systems are the predominant aquaculture practice in many developing countries, Nigeria inclusive, due to their cost-effectiveness and ease of management. The adoption of cage and tank methods portrays diversification in aquaculture practices. The mean monthly income was ₦67,100.54 with (31.4%) earning between ₦60,001 and ₦80,000 monthly. This income level suggests that fish farmers earn income below the national minimum wage (₦70,000). Singh et.al (2020) asserts that low-income farmers are often vulnerable and more exposed to climate-induced risk in production, because they lack the resources to use modern adaptation strategies. A significant proportion (25.9%) of the farmers had outputs of less than 200 kg monthly, while another 25.9% produced between 401-600 kg. Only a small portion (3.7%) of the fish farmers exceeded production levels of 1 ton per month. The mean monthly output was 441.09 Kg, which is less than 1 ton per month. This is in line with the findings of Max-Alaibo *et al*., (2021) who found out that fish farmers in the three Agricultural zones of Rivers State produced less than 1 tone of fish monthly. The result indicates that majority fish farmers operated on a small to medium scale. According to Ogello, *etal*., (2024), small and medium-scale fish farmers often lack the resources and infrastructure needed to adapt to climate-induced changes. The result on contact with extension agents showed that 48.1% of fish farmers have never had contact with extension agents, while 25.9% rarely received extension services. The inadequate extension support can negatively affect the adoption of climate-smart fish production adaptation strategies in the study area

Perceived Effects of Climate Change on Fish Farming

Data in Table 2 shows the effects of climate change on fish farming as indicated by the fish farmers in the study area. The major identified impacts were decreased fish output (83.3%), flooding in fish farm areas (81.5%) and unpredictable rainfall affecting breeding (73.2%). This result shows that the fish farmers in the study area already feel the effects of climate change. The ability of the fish farmers to identify the adaptive strategy that can mitigate the climate change impact is crucial for them to remain in business. The result is in line with the assumptions of (Yadav *et al.* 2024; Olutumise, 2023) who identified decreased fish output, breeding difficulty, among others, as some of the impacts of climate change on aquaculture. Other effects of climate change on fish farming identified include a rise in water temperature, outbreaks of diseases, and rising water acidity.

Table 2: Distribution of Fish Farmers According to the Perceived Effects of Climate Change on Fish Farming

Effects of Climate Change	Frequency (n=108)	Percentage (%)	Rank
Decrease in fish output	90	83.3	1st
Flooding in fish farm areas that can lead to the loss of fish	88	81.5	2nd
Unexpected rainfall makes breeding difficult, which may cause a scarcity of fries	79	73.2	3rd
Water temperature rise	78	72.2	4th
Disease outbreak	65	60.2	5th
Increase in water acidity	55	50.9	6th
High mortality rate	50	46.3	7th
Scarcity of quality water	47	43.5	10th
Water temperature rise	78	72.2	4th
Long periods of hot season decrease fish production	37	34.3	9th
Scarcity of quality water	47	43.5	10th

Field, Survey, 2024; *Multiple Responses Recorded*

Adaptive Strategies Employed by Fish Farmers in Asari Toru LGA

Table 3: Distribution of Fish Farmers by Adaptive Strategies Employed

S/N	Adaptive Strategies	Mean	Remark
1	Seeking early warning information about climate risk	3.26	1st
2	Construction of fish ponds with proper drainage	3.19	2nd
3	Diversification of fish species	3.13	3rd
4	Regular change of pond water	3.06	4th
5	Regular monitoring and maintenance of ponds	3.05	5th
6	Diversification of livelihood (doing other businesses)	2.93	6th
7	Siting ponds away from flood-prone areas	2.84	7th
8	Sinking of borehole	2.60	8th
9	Use of climate-resilient fish feeds	2.42	9th
10	Adoption of agroforestry practices	2.48	10th

Field, Survey, 2024; *Mean $\geq$ 2.50 Adaptive Strategies Used and Mean < 2.50 not an adaptive Strategy used*

The results on the adaptive strategies used by fish farmers in the study area as seen in Table 3 showed that seeking early warning information about climate risk with a mean of 3.26 ranked the highest, closely followed by the construction of fishponds with proper drainage (Mean = 3.19) and diversification of fish species (M = 3.13). Obtaining an early warning sign helps fish farmers to plan and prepare for future adverse climatic events, thereby increasing their resilience to climate change. Early warning information enables

them to make informed decisions by modifying and adjusting their management practices such as breeding time, type of feed, stocking, harvesting schedules, and water management. According to Pienaah *et al*. (2023), early climate information increased the preparedness and adaptive capacity among small-scale farmers in Sub-Saharan Africa. The construction of fishponds with proper drainage will enhance the flow of water and

oxygen circulation of the pond to maintain fish health. Also, the farmer indicated diversifying fish species as an adaptive strategy. Onyeneke *et al.* (2020) confirmed that fish farmers in Bayelsa preferred stocking the African catfish due to its high resistance to poor water quality conditions, disease, and tolerance to a wide range of climatic conditions. Other adaptive measures used by the farmers were the regular change of pond water, regular monitoring/maintenance of ponds, diversification of livelihood to non-fishery businesses, siting ponds away from flood-prone areas, and sinking of boreholes.

Constraints in using adaptive strategies

The major constraints encountered in the use of climate adaptive strategies as indicated in Table 4 were lack of training and technical know-how with a mean of 3.39, followed by insufficient funds and untimeliness of climate-risk information. Climate change adaptation in aquaculture requires knowledge and technicality in terms of early warning systems (weather forecast, stocking density, and harvesting time due to weather forecast), climate-smart fish farming (integrated farming system and use of improved fish species) and improved pond management systems (waste management, monitoring of water temperature, early detection/management of diseases and shading technology). Training on these parameters would enhance the farmers' adaptation capacity. Alawode and Ajagbe, 2020), identified training and technical know-how as a constraint to climate change adaptation among fish farmers in Southwestern Nigeria. Insufficient funds are another constraint faced by the respondents. Aquaculture is capital intensive; therefore, inadequate funding can disrupt the access to necessary knowledge, training, information, climate-smart infrastructure, risk management tools and technology because funds are need to invest in them. Insufficient funds obstruct effective adaptation and capacity-building efforts according to (Ifeanyi-Obi et al. (2024); Ojo et.al, 2020). Again, timely information is very crucial in fish farming as it enhances the farmers' preparedness to mitigate and adapt to climate-risk. Other constraints faced were high cost of modern equipment eg aerator, and water recycling systems, high cost of inputs such as feed, drugs etc, climate-induced disease in fish stocks, unpredictable weather patterns, inadequate storage facilities, Water pollution and contamination, Soil degradation and erosion and scarcity of climate-smart fish feed.

Table 4: Distribution of Fish Farmers According to the Constraints Faced in using the Adaptive Strategies

Constraints	Mean	Rank
High cost of modern equipment eg aerator, and water recycling systems	3.21	4th
Insufficient funds	3.36	2nd
Information on climate risk does not come early enough	3.22	3rd
Inadequate training and technical know-how	3.39	1st
High cost of inputs such as feed, drugs etc	2.91	7th
Climate-induced disease in fish stocks	2.97	5th
Unpredictable weather patterns	2.85	9th
Inadequate storage facilities	2.75	10th

Water pollution and contamination	2.96	6th
Soil degradation and erosion	2.70	11th
Scarcity of climate-smart fish feed	2.91	7th

Field, Survey, 2024; *Mean ≥ 2.50 Adaptive Strategies Used and Mean < 2.50, not an adaptive Strategy used*

Relationship between Fish Farmers Output and Climate Change Adaptive Strategies Used

Table 5: Correlation between Fish Farmers Output and Climate Change Adaptive Strategies Used

		Output of fish farmers	Adaptive strategies used
Output of fish farmers	Pearson Correlation	1	.104
	Sig. (2-tailed)		.457
	N	108	108
Adaptive strategies used	Pearson Correlation	.104	1
	Sig. (2-tailed)	.457	
	N	108	108

Field, Survey, 2024; *Significant at 0.05 level*

The result in Table 5 showed a weak positive relationship between the fish farmers' output and the adaptive strategies used in mitigating climate risk with a correlation coefficient of 0.104, in other words, fish farmers' output would increase as they employ more adaptive strategies. However, there was no statistically significant relationship between the farmers' output and adaptive strategies used, as the p-value (0.457) is higher than 0.05 which is the significance level. This result suggests that the adaptive strategy utilized by the respondents may not be effective enough to increase their output. This may be due to insufficient funds to purchase improved adaptive inputs, knowledge gap on the part of the fish farmers, wrong implementation of adaptive strategy, lack of modern or climate-smart tools, and use of traditional adaptive strategies that may not fit for their climatic-risk conditions.

Conclusion

The study concludes that the fish farmers in the study area used various adaptive strategies to mitigate the negative effects of climate change. The farmers operated on a small to medium scale with monthly output of 441.09kg and that the effects of climate change as perceived by the fish farmers were decreased output, flooding in fish farm areas, and unpredictable rainfall affecting breeding among others. The adaptive strategies used by the fish farmers include seeking early warning information about climate risk, construction of fish ponds with proper drainage and diversification of fish species among others. The constraints faced by the fish farmers in using the identified adaptive strategies were lack of training and technical know-how, insufficient fund and untimeliness of climate-risk information among other. There was no statically significant relationship between climate change adaptive and the fish farmers' output.

Recommendations

1. Agricultural extension (public and private) agencies should deploy more extension agents to Asari-Toru LGA of River State to meet the climate change adaptation training and information needs of the fish farmers.

2. The fish farmers should come together to form community, where they can source and share relevant climate change adaptive strategies and fish production related information, leveraging social media platforms to bridge the information gap.

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