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EVALUATING COST BENEFIT ANALYSIS OF CLIMATE SMART AQUACULTURE FISH PRODUCTION TECHNOLOGIES IN ONDO STATE, NIGERIA

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ABSTRACT

Aquaculture contributes to the livelihood of the rural communities, improved nutrition and food supply, employment and income generation for the people around the world. Therefore, this study examined the socio-economic characteristics of aquaculture fish farmers, in the selected areas in Ondo state, Nigeria, identified the types of climate smart production technologies practiced in the study area, determine the cost and returns per fish farmers and identified the production constraints and benefits using climate smart practices for fish production in the study area. Data collected from 80 aquaculture fish farmers were analyzed, using descriptive statistics, gross margin analysis and Likert scale. Result showed that the mean age of the respondents is 43 years while approximately 73% of the respondents were men. Majority of the fish farms was owned by individual. Predominantly in the rainy and dry season Earthen ponds were used at approximately 22% and 20% followed closely by concrete pond lined with tarpaulin at about 21% and 17% respectively. The study revealed that 43% has aquaculture as their major occupation and means of livelihood. About 48% of the respondents own the land being used for the fish farm and 73% make use of their own labour. The average gross margin was 21,629574.70 naira the total cost amounted to 3,203,405.30 naira, average net farm income was 21,819,000.00 naira and feed cost accounted for 91% of TVC. Conclusively, fish production using smart technologies in the Ondo State is profitable and economically viable. Hence, Government should facilitate access to credit by fish farmers in the study area by review of strict lending polices of the formal lending institutions.

KEYWORD: Cost-Benefit Analysis, Climate Smart Agriculture, Fish Production, Climate Change.

INTRODUCTION

The fisheries and aquaculture sector is a very important component of the food production systems in every society striving towards achieving the UN Sustainable Development Goal on food security. Therefore, programs and initiatives geared towards ecosystem restoration and food security have the imperative of inclusion of some aspects of fisheries and (or) aquaculture to be holistic and cost-effective. Under circular economy, the sector is very useful in the transformation of some agricultural and food processing wastes into useful resources for further food production while its own waste becomes useful in agriculture (Bosma and Verdegem, 2011; Dawood *et al*., 2018). Some of them can easily be cultured on wastes from different human domestic and industrial activities, especially food-processing wastes.

Fish provides not only proteins of high value but are source to a wide range of essential micronutrient minerals, vitamins and essential fatty acids (Highly Unsaturated Fatty Acids-HUFAs) very essential for human health (FAO, 2012). Fish is readily digestible and utilizable by human body, making it suitable for complimenting the high carbohydrate diets in most in most developing countries (FAO, 2008). Fish have all the essential amino acids required by the body. On the average, it provides 20-30 kilocalorie per person per day (WHO, 2011). The fisheries sector contributes 3-4.5% of the gross domestic product (GDP) in Nigeria and constitutes 50% of animal protein consumption (Federal Ministry of Agriculture and Rural Development [FMARD], 2008: Onada and Ogunlola, 2016). Fish consumption per caput is 7.5kg in Nigeria (FMARD, 2008) while the global average is 20.2kg (FAO, 2022).

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Nigeria spends approximately one billion dollars annually in the importation of a million metric tons of fish to augment the local production deficits (Obasi *et al*., 2017). The fisheries and aquaculture sub-sector employed one million one hundred and ninety thousand persons as at 2016, with women and youths involving more in the postharvest value chains (Subasinghe *et al.,* 2021)

Gender-sensitive approach implies measures or practices that will ensure that there is a balance of both male and female genders in the fisheries and aquaculture sub-sector. This becomes necessary given earlier reports indicating that different parts of both the fisheries and aquaculture value chain are being dominated by the male gender (Giwa *et al*, 2017; Unah *et al.*, 2017; Subasinghe *et al.,* 2021).

Climate change is the alteration of the pattern of the climate of a place over a given period of time: usually ten years and above. Recent weather events like changes in hydrological regime, drastic change in weather condition, reduction water levels, heavy windstorms, excessive sunshine, increased incidences of flooding and drought are being linked to climate change (Onada and Ogunlola, 2016).

Climate-Smart Fisheries Approach

Federal Department of Fisheries noted that climate change will affect fisheries strongly given that it will have impact on fishes on which fisheries depend (FDF,2021). It is envisaged that artisanal fisheries which currently accounts for 85% of local production (Obasi *et al*., 2017) will be affected through multiple weather events like windstorms, rising sea levels, warming that lead to migration and (or) extinction of some economic species (Evulobi, 2015) near the coast which may impede the capacities of the communities to operate. Warming is also expected to lead to more stratification of inland lakes leading to anoxic hypolimnion and ultimate fish kills (FDF, 2021). This is in addition to the challenge of unlicensed foreign fleets operating illegally in Nigeria's territorial waters and landing our fishes at foreign ports for importation back to Nigeria (Jim-Saki *et al*., 2017; Obasi *et al*., 2017). Already, the Nigerian fisher folks are grappling with lack of institutional support, good roads, storage and processing facilities and poor logistic infrastructure that has limited distribution of many commercial species to the south (Unah *et al.,* 2017; Subasinghe *et al*., 2021). These challenges are expected to be exacerbated by the impact of climate change; but can be addressed if some climate-smart measures are taken.

Climate-Smart Aquaculture

Aquaculture in Nigeria is still in its early stages of development with a contribution of only six percent to the local fish production (Obasi *et al*., 2017) and only two groups of fish, catfish and tilapia, being cultured in the output ratio of 6.5:1 respectively; and most of the farms located mainly in the southwest (Subasinghe *et al*., 2021). Estimated potential of aquaculture production per annum in Nigeria is 2.5 million metric tons (FMARD, 2008) but it currently accounts for a local annual production of 6% of the approximately one million metric tons from the fisheries and aquaculture sector, whereas local fish demand stands at two to three million two hundred thousand metric tons (Obasi *et al*., 2017; Chukwunonye and Amaechina, 2022). Aquaculture remains the among the fastest growing food sub-sector with a growth of 4.6% between 2010 and 2020 (FAO, 2022). Some of the challenges with aquaculture production which are also opportunities for investments are: availability and accessibility to better farming practices, availability of inputs: quality fish seed and feed. Accessibility of finance is also a limiting factor (Subasinghe *et al*., 2021).

To this end, a Cost Benefit Analysis (CBA) was conducted which provided a valuation of the project as implemented in Ondo state, adds to the existing knowledge on the performance of climate smart aquaculture (CSA), and perhaps points out areas for improvements. This offers a sound basis on which to make inferences on the performance of CSA in the entire country. This study aims to looks at "What fish farmers know about climate smart aquaculture and what are they doing about its impacts"?. Given the forgoing, these research questions were raised; What are the characteristics of aquaculture fish farmers in Ondo state, Nigeria? What climate smart aquaculture fish production techniques are presently available? Which of the existing climate smart aquaculture fish production practices is most viable for scalability? Why would fish farmers prefer to use a fish production technique over the others?

MATERIAL AND METHODS

Study Area

This study was be carried out in Ondo State, South-West of Nigeria. The state lies within latitudes 6^{o} and 9^{o} N of the equator and approximately between longitudes 2^{o} and 7^{o} E of Greenwich meridian .It is one of the land-locked states of the Federal Republic of Nigeria. It covers an estimated area of 8,062 square kilometers . The State runs an agrarian economy with a vast majority of the populace taking to farming. The state is a typical rain forest with mean annual rainfall varying between 880mm and 2600mm (CBN, 2000) and is characterized by the forest vegetation. It is limited to freshwater fisheries (Macmillan, 1992). Ondo state, according to the state Department of fisheries is divided into six fisheries zones with a total of over one hundred fish farms

Data collection

Primary data was used for this study. Primary data was collected through a farm field survey of aquaculture fish farmers. . Personal interviews was used with the aid of a structured questionnaire using the purposive sampling procedure to collect data from eight of the major settlements with major aquaculture activities and an influx of fish farmers in the State of Ondo.

The areas sampled are Akure North and South Local government. The communities sampled are Ijoka, Oke Aro and Awule for Akure South; Itaogbolu, Oba ile, Igbatoro, Igoba and Ogbese for Akure North Local government followed by was the sampling of 10 fish farmers from each of the settlements under study and are selected randomly, making a total of 80 respondents.

Data analysis

Data obtained were analyzed using the Descriptive Statistics,Gross Margin analysis and Likert Scale formula.

Descriptive statistics namely frequency distribution, mean, standard deviation and percentage was used to analyze the socio-economic characteristics of the respondents and climate smart aquaculture practices available in the study area.

Gross margin analysis was used to estimate the cost and return of climate smart aquaculture fish production and analyze the economic reliability of climate smart aquaculture fish production in the study area.

GM = TR – TVC

Profit(π) = GM – TFC

GM = Gross margin

TR = Total Revenue

TVC = Total Variable Cost

TFC = Total Fixed Cost

Likert Scale Formula:

$X = \frac{\sum X1}{N}$

Where n = 1,2,3,4……n

N = the number of occurrences

X = the assigned value of constraint

∑ = summation sign

Where:

X_1 = Productivity,

X_2 = Level of Technology,

X_3 = Rough Handling,

X_4 = Water Management,

X_5 = Method of Storage,

X_6 = Selling at reduced Price,

X_7 = Low patronage

RESULTS AND DISCUSSION

Socio-economic characteristics of Fish farmers in Ondo state.

The description of the socioeconomic characteristics of fish farmers in Ondo State, Nigeria is presented on Table 1.It reveals that 72.5% of the farmers were males, indicating a male dominance among the fish farmers. This could be as a result of the fact that farm operations are tasking and it requires much energy and effort. Age distribution of fish farmers reveals that majority (35%) of the respondents fell within the age of 36 and 45, while the mean age was 43years.This implies that the farming operations in the study area has an active work force and are relatively young. The distribution of marital status among the maize farmers revealed that 75% of the farmers were married. The high proportion of the married respondents implies that married people would have an additional labour supply from the family for farm operations.

Table 1 further shows that 62.5% of the maize farmers had tertiary level education, indicating that majority of the maize farmers in the study area are well literate having at least secondary education. This would enable them acquire the necessary skills and adopt innovations needed to succeed in the aquaculture business. Moreover, majority (47.5%) of the farmers had farming experience of 6 to 10 years.This wealth of experience would help them in handling any related on farm related issuesor challenge as soon as they arise. The types of pond used by fish farmers from Table 1 shows that during during the rainy and dry season the Earthen pond and Concrete pond lined with tarpaulin were the predominant (21.7% and 19.8%) type used in the study area respectively. Table 1 further reveals that the major source of labour is personal labour with a staggering percentage of 72.5%.

Profitability analysis of Fish production

Result from table 2 shows the cost and return analysis of fish farming production cycle in Ondo state. The average total fixed cost is put at 3,013,980.00 naira while the total variable cost is 189,425.3 naira giving a total cost of 3,203,405.30 naira. The total revenue is 21,819,000.00 naira and the net farm income is 18,615,594.70 naira while the Gross margin is estimated at 21,629,574.7 naira.This reveals that the marketing of fish is a profitable venture since the gross margin was greater than zero and in the short run should be encouraged in the study area.

Effects of Aquaculture production without climate smart practices

The result showing the effects of aquaculture production without climate smart practices in Ondo state are presented in Table 3 with Environmental degradation ranking first and having a weighted mean of 7.31, closely followed by soil and water erosion with mean of 6.88, coming third is Low farm income with mean of 6.75, others are low pond productivity, Presence of predators, Water scarcity and Pest/Diseases infestation with means of 6.68, 6.58, 6.03, 5.65 respectively.

Table 1: Distribution of socioeconomic characteristics of Fish farmers in Ondo state.

Variable	Frequency	Percentage
Age(in years)	**n=80**	
26-35	20	25
36-45	28	35
46-55	24	30
55-65	8	10
Mean (Age)	43	
Gender		
Male	58	72.5
Female	22	27.5
Marital status		
Single	20	25
Married	60	75
Educational level		
Adult literacy	20	25
Secondary education	10	12.5
Tertiary level	50	62.5
Years of experience		
5 and below	30	37.5
6-10	38	47.5
11-15	10	12.5
16-20	2	2.5

Table 2: Costs and Returns of Fish Farming Production Cycle

Items	Cost Estimate (₦)	Percentage of Cost (%)
Fixed costs		
Pond construction	**2,786,175**	**92.44**
Fencing	**42,375.00**	**1.41**
Nets	**4,512.50**	**0.15**
Weighing scale	**7,562.50**	**0.25**
Borehole	**36,105.00**	**1.20**
Land	**137,250.00**	**4.55**
Total Fixed Cost (TFC)	**3,013,980.00**	**100**
Variable Cost		
Feed	**172,312.50**	**90.97**
Lime	**2,380.00**	**1.26**
Fertilizer	**500.00**	**0.26**
Drugs/Supplements	**1,302.50**	**0.69**
Hired labour	**1,962.50**	**1.04**
Pumping machine (Fuel)	**1,767.75**	**0.93**
Miscellaneous	**9200**	**4.87**
TOTAL VARIABLE COST (TVC)	**189,425.3**	**100**
TOTAL COSTS (TC)	**3,203,405.30**	
C. REVENUE		
TOTAL REVENUE (TR)	**21,819,000.00**	
NET FARM INCOME (TR-TC)	**18,615,594.70**	
GROSS MARGIN (TR-TVC)	**21,629,574.7**	

Source: Field Survey, 2019.

Table 31: Effects of aquaculture production without climate smart practices

Attitudinal Statements	SD	D	I	A	SA	Weighted sum	Weighted mean	Weighted Ranking
Low pond productivity	78	2	0	0	0	534	6.68	4th
Soil and water erosion	62	18	0	0	0	550	6.88	2nd
Environmental degradation	50	20	7	3	0	563	7.31	1st
Low farm income	42	23	0	12	3	540	6.75	3rd
Presence of predators	38	13	2	20	5	526	6.58	5th
Pest/Diseases infestation	0	0	0	72	8	452	5.65	7th
Water scarcity	0	0	10	52	18	482	6.03	6th

Source: Field Survey,2019

Benefits of Aquaculture production with climate smart practices

Table 4 shows the benefits of aquaculture production in Ondo state with smart climate practices using linkert scale to generate the weighted mean. The table shows Improved pond fertility is ranked first with a weighted mean of 7.62. ranking second is Absence of predators with mean of 7.30, others include Improved water management, Reduced water pollution, Improved off-season production and Improved pond productivity with means of 7.20, 6.83, 6.75, 6.58 respectively.

Table 4: Benefits of aquaculture production with climate smart practices

Importance you attached	SD	D	I	A	SA	Weighted sum	Weighted mean	Weighted Ranking
Improved pond fertility	**0**	**0**	**2**	**78**	**0**	**610**	**7.62**	**1st**
Improved off-season production	**0**	**20**	**16**	**44**	**0**	**540**	**6.75**	**5th**
Reduces water-pollution	**0**	**38**	**6**	**36**	**0**	**546**	**6.83**	**4th**
Improved water management	**0**	**38**	**16**	**26**	**0**	**576**	**7.20**	**3rd**
Improved pond productivity	**0**	**34**	**2**	**44**	**0**	**526**	**6.58**	**6th**
Absence of predators	**2**	**50**	**10**	**18**	**0**	**584**	**7.30**	**2nd**

Source: Field Survey,2019

CONCLUSION AND RECOMMENDATIONS

Findings from the study concluded that the fish farmers in the study area are aware of the climate smart aquaculture fish production technologies and were also willing to make use of these technologies to improve their production level as well as their standard of living. Based on the findings of the study,adequate trainings and seminars should be held at intervals to update fish farmers' knowledge on climate smart aquaculture fish production technologies and procedures; as well as to fill the gap created by poor contact with extension agents.

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