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Full Length Research Paper

Rural water utilization: Factors affecting aquaculture in Owo local government area of Ondo State, Nigeria

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The study was on factors affecting aquaculture in Owo local government area of Ondo state, Nigeria. Despite the challenges being faced by the rural people of the study area in accessing water for various uses, they still had a very good utilization of the available water for aquaculture. However, several factors of which the major ones were number of ponds owned, size of farm, years of aquaculture experience and cost of land with some others were still affecting aquaculture in the study area. Regression analysis result showed that the number of ponds owned (0.727) and size of farm (0.071) were positively correlated to the farmers revenue while years of experience (-0.041) and cost of land (-0.513) had negative impact on farmers revenue. The concept of costs, returns and profitability is also discussed to show how well aquaculture was doing in the study area as a source of income generation.

Key words: Aquaculture, factors, fish, pond, profitability, revenue.

INTRODUCTION

Aquaculture is the farming of aquatic plants and animals. Fish culture is one very good example of this process that deals with fish rearing or production in a controlled environment like ponds, tanks, reservoirs, cages, irrigational canals and other types of enclosures (Adesulu, 2004). The process comprises of a wide spectrum of culture practices. It varied from a simple fish culture in excavated earthen ponds with little or no feeding to the highly sophisticated farming systems. There are specially designed ponds, as well as cages and raceways, requiring aeration and periodic replacement of freshwater. This special agricultural process requires inputs in the form of feed, drug and use of chemicals for the survival of the aquatic products.

Trends in production and utilization of fish

World fish production rose in 1989 to over 100 million ton in total as reported catches in the 1990s (FAO, 1995). Although, this figure declined between 1990 and 1992, preliminary data for 1993 indicate that total production amounts to over 101 million tons. Of this catch, about 30% was utilized for non-food purposes, mainly for reduction to fish meal and oil. Fresh fish is the most important fish product for direct human consumption, its share of total production remaining at around 30% between 1970 and 1990 (Delgado et al, 2003 and FAO, 1995).

World production from capture fisheries and aquaculture supplied about 101 million tons of food fish in 2002, providing an apparent per capita supply of 16.2 kg (live weight equivalent), with aquaculture accounting for the growth in per capital supply since 2000. Overall, fish provided more than 2.0 billion people with at least 20% of their average per capital animal protein intake. The share of fish proteins in total world animal protein supplies grew from 14.9% in 1992 to a peak of 16% in 1996 and remained close to that level (15.9%) in 2001 (FAO, 2004).

On the African continent, more than 10 million people rely on fisheries as a vital entrepreneurial activity. Over 2.5 million fishers make business opportunities available for many processors, traders and micro enterprises in relevant industries. For most of them, the fishing industry is a good avenue for income generating activity. Of Africa's 800 million people, over 200 million are regular fish eaters. To them, fish is an essential aspect of their nutrition, accounting on average for 22% of their animal protein intake reaching up to 70% in some countries (World Fish Centre, 2005).

In Nigeria, the national demand for fish is estimated as

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high as 1.4 million metric tons with a wholesale value of more than $1 billion (Ikpe, 1996). The Federal Department of Fisheries (1985) indicated that 511,000 metric tons of this estimated demand are provided domestically or only about one third of demand. Only a few thousand Nigerians are employed in the high cost, low profit industrial fishing, which contributes only 10% of the domestic catch. On the contrary, artisanal (small-scale) fishermen/women number about one million and consistently contribute 85% or more of the domestic fish catch (National Special Programme for Food Security, 2005). Even with unreasonably high fish imports, there remains a significant shortfall in supply to meet demand. This is in contrast to an estimated national potential of fish production of 3.2 million tons per year (Aquaculture and Inland Fisheries Project, 2005).

The importance of fish as a crucial element in diets, especially the diets of infants, young children and pregnant women, is now widely recognized. The contribution of fisheries to the gross domestic product is only between 3 and 4%, yet, it occupies a very significant position in the primary sector providing direct employment for over a million people (FAO, 2004). Fish production contributes about 50% of the animal protein intake of the 120 million populations, particularly the resource poor (International Financial Corporation, 2003). Perhaps as many as 6 million people are indirectly employed in the upstream and downstream value chain in fisheries. The rapidly growing fast food industry is now seeking processed catfish and this could open up employment opportunities in the downstream value chain for handling, processing and marketing of fish (Aquaculture and Inland Fisheries Project, 2005).

Systems of fish culture

An important characteristic feature of aquaculture is that it can be organized as systems. Osuigwe (2006); Ayodele and Ajani (1995) describes 3 systems of aquaculture as follow:

Extensive: Adoption of traditional techniques of aquaculture which depend on natural productivity and little control over the stocks. Some fish obtain the food exclusively from plankton e.g. Silver carp. Others such as tilapias feed on plankton and also on bottom materials.

Semi-intensive: This level of farming takes full advantage of natural aquatic productivity, fertilization and using prepared feed as supplement to increase yield further. The additional yield of fish resulting from additional feeding is profitable. With catfish yields of 370 kg/ha are obtained from fertilized ponds. With supplements of high protein feed yields of 5000 kg/ha are obtained in static ponds.

Intensive: Adoption of full complement of culture techniques including scientific pond design, full measure of stock manipulation, feeding, disease control and scientific harvesting. With this system maximum yield per unit of space and effort is a primary concern and highly concentrated nutritionally complete feeds are justified.

Apart from the differences in the physico-chemical characteristics of its habitats, (freshwater, brackish water and sea water) aquaculture systems are of several kinds. The systems are variable in magnitude and intensity, ranging from homestead (backyard) units to large-scale commercial ventures (Osuigwe, 2006; Williams, 1987). They include:-

Ponds: Are bodies of water that are usually smaller than lakes. Most ponds used for fish culture are manmade. 2 primary types are used: embankment and excavated ponds. Embankment ponds are formed by building up a dam, dike or similar above ground structures to impound water.

Tanks: The difference between tanks and ponds is primarily one of size and perhaps materials of construction. Tanks are smaller and constructed of concrete or other suitable materials. The ideal culture tanks are smooth on the interior, self-cleaning, durable and of sufficient strength to withstand stresses, easily cleaned, not corrosive and an inexpensive as possible.

Flow-through systems: The real breakthrough in fish culture came with construction of flow-through systems after realization that not the size of the water area but the quantity of water flowing through limited the yield. Fish culture in flow-through system is a type of intensive culture where the fish are stocked densely in a long and narrow pond or tank in which there is abundant continuous water flow.

Raceways: Are rectangular ponds considerably longer than they are wide and usually shallow (1 - 2 m maximum) through which a significant volume of water flows. Stocking density can be much higher than in ponds allowing more fish to be raised within small surface area.

Re-circulation system: Recirculation system is that type of cultivation unit in which the outflow of the rearing tank/ponds is partially or completely re-circulated to them. There are 2 basic types: the simple recirculation system and the complex recirculation system.

A simple recirculation system is one where the water supply needed to support a certain animal population is decreased by employing aeration and or water treatment while a complex recirculation system is the one in which a high reduction of water supply can be achieved by employing a water treatment unit with re-aeration, mechanical filtration and biological treatment. The water requirement may be reduced as much as one-tenth.

METHODOLOGY

Study area

The area of study is Owo local government area which is one of the

Table 1. Summary of registered fish farms in Ondo state.

S/N	Local government	Number of fish farmers
1	Akoko North East	41
2	Akoko North West	13
3	Akoko South East	3
4	Akoko South West	6
5	Akure North	34
6	Akure South	181
7	Ese Odo	21
8	Idanre	8
9	Ifedore	63
10	Ilaje	102
11	Ile Oluji/Okegbo	16
12	Irele	8
13	Odigbo	13
14	Okitipupa	45
15	Ondo East	1
16	Ondo West	93
17	Ore	20
18	Owo	122
	Total	788

Source: Ondo State Fisheries Department, 2008.

18 local government areas (LGAs) in Ondo State, Nigeria. Quite a large number of the populations were engaged in aquaculture business in the local government (2nd highest) compared to others. (Table 1). The local government's demography can be described as a rural as well as an urban area though the rural area is more than the urban.

Data collection

A total of 50 respondents were randomly selected among the 122 registered fish farmers in the study area and questionnaires administered on them.

Regression analysis and model

The multiple regression model was used to show the degree to which each independent variable explained the variation in the dependent variable.

The importance and performance of the parameters used and the elasticity of output were determined using ordinary least square (OLS) regression method.

Linear form: $Y=f(x_1, x_2, x_3, x_4 \ldots x_n)$
Model
$Y=\alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 \ldots\ldots + \beta x_n$
α=constant, $\beta\beta_1, \beta_2, \beta_3, \beta_4$ = standardized regression coefficients, x_1 = Number of ponds owned, x_2 = cost of land, x_3 = size of farm, x_4 = years of experience

RESULTS AND DISCUSSION

Majority of the farmers had less than one acre of farmland (48%), while 34% of them had between 1 - 5 acres of farmland. 10% of the farmers had between 6 and 10 acres while another 8% had between 11 - 15 acres farmlands respectively. The results of the study conducted are in tandem with the view held by Akinyemi (1998) that fish farming enterprises on farmlands below 6 ha are small-scale farms and fish farming on farmlands above 6 ha is large-scale farms (Table 2).

Table 2. Size of Farm of the Respondents.

Size of farm	Frequency	%
< 1 acre	24	48.0
1 - 5 acres	17	34.0
6 - 10 acres	5	10.0
11 - 15 acres	4	8.0
Total	50	100.0

Source: Field survey, 2008.

Table 3. Distribution of respondents according to land acquisition

Mode of acquisition	Frequency	% age
Gift	6	12.0
Inheritance	9	18.0
Purchased	35	70.0
Total	50	100.0

Source: Field survey, 2008.

Land acquisition

A larger %age (70%) of the respondents in the study area acquired their lands through outright purchase process. This showed that they were the rightful owners of the business and that the land was not leased out to them. 12% of the farmers got their lands as a gift item while 18% inherited their farms from their parents (Table 3).

Number of ponds

Table 4 shows that majority of the farmers (56%) had 1 - 3 ponds, 22% of the respondents had 4 - 7 ponds; 8% had 8 - 11 ponds. Only a handful of the farmers were operating on a medium to large-scale level and they owned over 12 ponds.

Types of ponds

The findings reveal that 58% of the respondents have earthen ponds, 32% have concrete ponds, 4% have pu-

Table 4. Distribution of respondents according to the number of Ponds.

Number of Ponds	Frequency	%age
1 - 3	28	56.0
4 - 7	11	22.0
8 - 11	4	8.0
> 12	7	14.0
Total	50	100.0

Source: Field survey, 2008

Table 5. Distribution of respondents according to their type of ponds.

Type of Pond	Frequency	Percentage age
Earthen pond	29	58.0
Concrete pond	16	32.0
Public pond	2	4.0
Bowl pond	3	6.0
Total	50	100.0

Source: Field survey, 2008.

blic ponds while 6% have bowl-type ponds. This result revealed that earthen ponds are more common in the study area than any other type of pond. This is due to the high productivity level of earthen pond because fishes have access to the natural productivity of the pond (Zooplankton and phytoplankton) in addition to the artificial feeds, vitamins and supplements they were being fed to ensure adequate growth rate. Also, concrete ponds were used by farmers who had limited land space or because this type of ponds were easier to manage (Table 5).

Table 6. Distribution of respondents according to the Sources of water used.

Sources of water used	Frequency	Percentage age
Borehole	16	32.0
Well	20	40.0
Spring	5	10.0
Stream	9	18.0
Total	50	100.0

Source: Field survey, 2008.

Sources of water used

For optimum performance of species being cultured, good quality water is a requirement. As indicated in Table 6, 40% of the respondents depended on well water for the supply of water used on their farms because this was less expensive and was also readily available for other domestic uses. 32% of the respondents relied on borehole for water supply to their ponds and this showed that the use of borehole water was common in the study area. This represented a clean source of water supply both for drinking and fish culture. 10% of the farmers depended on spring water for supply of water to their ponds while 18% relied on stream water.

Table 7. Mechanism of determining fish Prices.

Methods	Frequency	Percentage age
Prevailing price	42	84.0
Haggling	8	16.0
Total	50	100.0

Source: Field survey, 2008.

Mechanism of determining fish prices

As indicated in Table 7, 84.0% of the respondents determined the price they sold their fish through the prevailing price in the market. This is to show that there was a little bit of consensus among the farmers as regard the price of a particular quantity of fish. Only 16.0% of the respondents determined their prices through haggling.

Table 8. Distribution of respondents based on harvest duration within a year.

Number of times of harvest	Frequency	Percentage age
Once	20	40.0
Twice	29	58.0
Thrice	1	2.0
Total	50	100.0

Source: Field survey, 2008.

Harvest duration within a year

Cropping or harvesting of a fish pond takes place when the fish stock has reached market size. Table 8 shows that a lot of the farmers harvested more than once in a year. 58% of the fish farmers harvested twice in a year while 2% harvested thrice. 40% harvested once in a year. The findings show that those farmers that harvested twice or thrice in a year must have put in a lot in terms of feeding and management and the total yield as a result of multiple harvests will be greater than the yield from a single harvest.

Other factors affecting aquaculture

In Table 9, 16% of the fish farmers indicated that their major problem was high cost of inputs, 22% revealed that their major problem was inadequate credit facilities, 2% indicated lack of land, 4% indicated theft/poaching as their problem, 26% indicated diseases as their main problem, 6% indicated high mortality as their main problem, 20% revealed that their major problem was lack of quality feeds while 4% of the farmers indicated that water pollution was their main problem.

Concept of costs, returns and profitability

Cost has to do with all the expenses that the farmer incurred in raising a marketable fish. The components of cost in aquaculture business are fixed and variable costs. Fixed costs in respect of this study were the expenses incurred in buying land, pond construction, building, fencing and purchasing nets. Variable costs were the expenses incurred on feed, lime, fertilizer, fingerling, drug, labour and transportation.

TC - Total costs
TVC - Total variable costs
TFC - Total fixed costs

Revenue

Returns in aquaculture business refer to the total revenue generated from selling fish. In respect of this study, it is the product of kilogram of fish sold and the unit price for each fish.

Profitability

It is the difference between total revenue and the total costs of production. Profitability in aquaculture business depends on a number of factors particularly on the amount of capital invested in the business.
Profit = Total revenue (TR) - Total cost (TC)

Analysis of variable cost

The average variable cost of the farmers in the study area was indicated in the Table 8.

From Table 10, it is clearly shown that fish feed had the highest percentage age (37.1%) of the average variable costs. This finding shows that feed was a significant factor for any aquaculture business to succeed.

Table 9. Other Factors affecting Aquaculture apart from number of ponds owned, cost of land, size of farm and years of experience.

Problems	Frequency	Percentage age
High costs of inputs	8	16.0
Inadequate credit facilities	11	22.0
Lack of land	1	2.0
Theft/poaching	2	4.0
Diseases	13	26.0
High mortality rate	3	6.0
Lack of quality feeds	10	20.0
Water pollution	2	4.0
Total	50	100.0

Source: Field survey, 2008

Table 10. Average variable cost (AVC) (#/Acre) for 2008 season.

Variables	TVC (₦)	AVC (₦)	Age distribution (%)
Feed	6317400	126348	37.09
Lime	588800	11776	3.48
Fertilizer	666600	13332	3.91
Fingerling/fry	947640	18952.8	5.56
Drug	33200	8664	2.54
Skilled labour	4320060	86401.2	25.37
Semiskilled labour	402480	8049.6	2.36
Unskilled labour	3027000	60540	17.77
Transportation	291600	5832	1.71
Miscellaneous	36000	720	0.21
Total cost	17030780	340615.60	100.0

Source: Data analysis, 2008.

Fingerling cost constituted about 5.6% of the AVC which reveals that some of the farmers produced their own fingerlings. Skilled labour constituted 25.4% of the AVC which shows that farmers with a lot of ponds needed experts for effective management of their farms. Fertilizer cost accounted for 3.9% of the average variable cost which reveals that farmers could be using poultry wastes as organic fertilizer and purchasing less amount of inorganic fertilizer.

Analysis of fixed costs

The fixed cost items in respect of this study were cost of acquiring land, pond construction, cost of building,

Table 11. Average fixed cost (# acre) for 2008 season.

	TFC (N)	AFC (N)	Percentage age distribution
Land	7114400	142288	39.89
Pond construction	7477000	149540	41.91
Building	610000	12200	3.42
Fencing	1796000	35920	10.07
Nets	522500	10450	2.93
Others	318000	6360	1.78
Total	17,837,900	356,758	100

Source: Data analysis, 2008.

fencing and cost of buying nets. Table 11 reveals that average cost of acquiring land in the study area was ₦142, 288 representing 38.9% of the total fixed costs. This was followed in rank by pond construction cost (41.9%), cost of building (3.4%), cost of fencing (10.1%) and cost of nets (2.9%), other costs (1.8%) in that order.

Analysis of total cost of production

Average total cost is the addition of average fixed and average variable costs. It is shown from this study that AFC was ₦356, 758 per acre/season while AVC was ₦340, 615.60 per acre/for 2008 season (Table 12).

Total cost = AFC + AVC
= ₦356, 758 + ₦340, 615.60
= ₦697, 373.60/ 2008 season

Analysis of gross revenue

Result findings when analyzed gave the average gross revenue for 2008 season at a sum of ₦2, 092, 900 from the sale of adult fish and fingerling.
Total revenue (TR) = ₦2, 092, 900/season
Net profit = Total revenue - Total cost
= ₦2, 092,900 - ₦697, 373.60
= ₦1, 395,526

This shows that aquaculture business is highly profitable and a good source of income in the study area.

The standardized coefficients were used to find the magnitude of each of the explanatory variables in order to know which one accounted more for the variation in the dependent variable. From the coefficient Table 13,

$Y = -1311581 + 0.727x_1 - 0.513x_2 + 0.710x_3 - 0.410x_4$ - - - - - (1)

The R^2 value, 0.896 showed that the independent variables (x_1, x_2, x_3 and x_4) accounted for 89.6% of the total variation in the dependent variable (Y). This means that 10.4% of the total variations in the dependent variable were unaccounted for by the independent variables and other factors or variables could have been responsible for this. The adjusted R^2 was used to find the exact relationship between the dependent variable and the independent variables. The adjusted R^2 value of 0.870 revealed that 87.0% of the total variation in the dependent variable (Y) was explained by the independent variables (Table 14).

The Durbin - Watson value of 2.259 showed that there
The Durbin - Watson value of 2.259 showed that there
was no autocorrelation between the dependent variable and the independent variables.

Significance of results

$Y = -1311581 + 0.727x_1 - 0.513x_2 + 0.710x_3 - 0.410x_4$ - - - - - (i)

The equation (i) above shows that the independent variable x_1 (number of ponds owned) with a value of 0.727 contributed most to the variation in the dependent variable (Y) followed by x_3 (size of farm) with a value of 0.710 while x_2 (cost of land) and x_4(years of experience) had negative impacts on the dependent variable.

The result therefore indicated that the number of pond owned by the farmer was a basic factor in aquaculture production and a major determinant of farmer's revenue. The regression coefficient with a value of 72.7 implies that a unit increase in the number of pond will increase farmer's revenue by about #72.7. This finding goes to suggest that for a fish farmer to realize substantial amount of revenue as well as profit from his aquaculture business, the number of ponds must increase.

The cost of land (x_2) was negatively correlated to farmer's revenue. This suggests that the higher the cost of land the lower the farmer's revenue. The regression coefficient 53.1 suggests that a unit increase in the amount spent on acquiring land would reduce farmer's revenue by about ₦53.1. This is because higher cost of land reduces the number of ponds a farmer could have. Higher cost of land also reduced the amount of capital that could have been used in managing a fish farm successfully.

The size of farm is positively correlated to farmer's revenue. The regression coefficient 71.0 suggests that a unit increase in the size of farmer's farm will increase the level of farmer's revenue by ₦71.0.

The years of experience was negatively correlated to farmers' revenue and could be as a result of the farmers resting on their oars. The negative correlation of the years of experience may also connote that diminishing returns set in on fish farmers.

Conclusion and recommendations

The major factors influencing aquaculture in the study

Table 12. Analysis of average cost and returns to fish farming enterprise in the study area for 2008 season.

			N	N
Average revenue				
Average variable cost				
ITEMS	**AVC (N)**	**% Distribution**		
Feed	126348	37.09		
Lime	11776	3.48		
Fertilizer	13332	3.91		
Fingerling/fry	18952.8	5.56		
Drug	8664	2.54		
Skilled labour	86401.2	25.37		
Semiskilled labour	8049.6	2.36		
Unskilled labour	60540	17.77		
Transportation	5832	1.71		
Miscellaneous	720	0.21		
Total variable cost	340,615.60	100	340,615.60	
Gross Margin				2752284.4
C. **Average fixed costs (AFC)**				
ITEMS	**AFC (N)**	**% Distribution**		
Land	142288	39.89		
Pond construction	149540	41.91		
Building	12200	3.42		
Fencing	35920	10.07		
Nets	10450	2.93		
Others	6360	1.78		
Total fixed cost	356,758	100.0	356,758	
D Net Profit				1,395,526.40
E. Return to Management				1,395,526.40

Source: Data analysis, 2008.

Table 13. Coefficients.

Model	Unstandardized Coefficients B	Standard Error	tandardized Coefficients Beta	t	Sig.
1 (Constant)	-1311581	898517.3		-1.460	0.164
No. of ponds owned	822951.7	103951.8	0.727	7.917	0.000
Land cost	-33.221	6.168	-0.513	-5.386	0.000
Farm size	25156.495	128113.1	0.071	6.823	0.020
Years of experience	-25058.4	60707.572	-0.047	-0.413	0.685

Source: Data analysis, 2008.

Table 14. Adjusted R-square and Durbin - Watson.

Model	R	R Square	Adjusted R Square	Standard Error of the Estimate	Durbin-Watson
1	0.947	0.896	0.870	1374909.634	2.259

Source: Data analysis, 2008

R^2 = Coefficient of multiple determination

R = Correlation coefficient

area were mainly number of ponds owned, cost of land and size of farm and years of experience. The following factors were also identified as affecting aquaculture in the study area though not in the magnitude of the ones mentioned above. They are:

i.) High cost of inputs (fertilizer, fingerlings, lime, feeds, etc) needed in raising fish successfully.
ii.) Poaching/theft of fish by others.
iii.) Inability of fish farmers to get loans.
iv.) Difficulty of farmers in managing or curtailing incidence of diseases as a result of insufficient fishery experts to run to in the case of a disease outbreak.
v.) Lack of feed supply distributors.

Despite these factors, aquaculture was still a lucrative source of income in the study area. For aquaculture therefore to develop maximally in the study area, the following are hereby recommended:

i.) The State Government in collaboration with the Local government should create more awareness on the importance and contribution of aquaculture production to poverty eradication, and promoting their inclusion in development plans and poverty alleviation strategies, particularly through better communication of research messages to fish farmers.
ii.) The State Government in conjunction with the Local Government should encourage human capacity deve-lopment in aquaculture production through face-to-face mechanisms which include classroom-based training, seminars, conferences and workshops, demon-stration trials, on-the-job training and mentoring, exchange programmes.
iii.) The fisheries department of the state ministry of agriculture should support fish farmers to improve their management and enhance their productivity by subsidizing fish inputs (juvenile, fingerling, lime, feeds and fertilizer) and making them available at various local governments.
iv.) Micro-credit finance scheme should be provided by the State Government through the Local Government while banks and other financial institutions should be encouraged by the government to make loans available to fish farmers at reduced interest rate with little or no collateral security.
v.) The fish farmers should be more pro-active towards their association by contributing both human and material capital to its development so that they will be able to get whatsoever they need in case the State or Local Government is unable to meet their needs either in the area of input supply or other needs.

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