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DETERMINING OPERATIONAL EFFICIENCY IN AQUACULTURE ENTERPRISE TO BOOST FISH PRODUCTION FOR IMPROVED FOOD SECURITY IN SOUTHWEST, NIGERIA

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Abstract

The mainintent of the research is to: (i) establish the cost-effectiveness of aquaculture fish farmers in the study area; (ii) evaluate how efficient the fish farmers are in theiruse of resources; (iii) ascertain the variables inducing the efficient use of resources; (iv) and establish the majorlimitations encountered by the owner and manager of fish farm enterprisein the area of study. Multistage samplingprocedure was used to select 180 aquaculture fish farmers in the area of study. Some analytical methods such as net profit margin ratioand efficiency model were used to investigate the collected data on the field.The result revealed that the average age of the respondents was 35.8 years. Their average years of experience in fish farming enterprise was 12.9 years. The net profit margin ratio was 21.96%, the operating expense ratio was 72.76% and the fixed cost ratio was 5.29%. The study further shows thatgender, educational level, aquaculture fish farming experience, pond size, association/cooperative membership and access to extension agents had positive value and significantly influence the aquaculture fish farmer's operational efficiency in the area of study. The research recommends that aquaculture fish farmers should be sensitized on the need to acquire more education and make use of the extension agents in their aquaculture fish farming.

Key words**:** *aquaculture, fish farmers, profitability, operational efficiency, efficiency*

INTRODUCTION

The prevailing food arrangement in Nigeria are not capable of achieving the main objective of ensuring the availability of nutritious and healthy food for all to fulfil the Sustainable Development Goals (SDGs) of food security for all. There are a lot of factors militating against this goal, such as dynamic diets, technology, urbanization and climate change [10].One of the very good attributes of fish is that it is a low-cost source of animal protein [15]. The deficit in national fish output in Nigeria is due to the declination of the sub-sector and climate change risk effects on fish production. This has led to increase in importation of fish in Nigeria [36].The available information on aquaculture in Nigeria bear witness to this fact. In 1990, aquaculture's contribution to total fish production was 2.3% and by 2021, its contribution has increased to 21.7% [22].

In Nigeria, farming is one of the primary responsibilities of many in the rural area of the country, even those in the urban cities often involve in farming activities. This is in various and diverse form like crop production, livestock breeding, fishery and forestry. Hence, many are employed in the agricultural sector of the economy [29]. More than 80% of Nigeria population are poor, and such reside in rural areas and work mainly in agriculture sector of the economy [1]. Up to 25% of Nigeria's Gross Domestic Products (GDP) emanates from agriculture related activities, and about 70% of the national labour force is engaged in agriculture, manufacturing industry and mining accounts for 10%, while 20% are in services [20]. Therefore, Nigeria's economy is mainly agricultural dominated economy; agriculture is the dynamic force for the country's economic growth. It is well known that fish is an inexpensive source of animal protein, the shortage in national production as

a result of inattention of the sub-sector by government at all levels (Federal, State and Local Government Area (LGA)) led to increase in importation of fish in Nigeria [5]. So, the growth of aquaculture industry in Nigeria came to reduce the gap between supply and demand [23].

Due to the shortfall of fish in Nigeria, there is critical need to investigate all avenues to ensure sustainable increase in fish supply. Various factors such as water pollution from oil spillage in the oil producing part of the country led to drop-off catches from capture. In view of the above, there is need to step up the aquaculture fish production to arrest the demand-supply deficit for fish in Nigeria. This involves culturing fish in a controlled environment that ensure proper monitoring of their feeding, growth, reproduction and health. Such cultured fish are already bridging the deficit gap in Nigeria and most less develop countries of the world [37].

Fish contribution to the national daily dietary energy supply is also very crucial in Nigeria. It is very difficult to come by alternative locally produced protein, therefore, in most family, preference for fish is very high. Fish contribution to dietary energy is highly substantial in Nigeria [8]. Essential foods like rice, wheat, maize and cassava constitute most of the food consumed by the people, and accounting for the bulk of energy and nutrients [6]. However, the necessary nutrients are not found in these staples or are found only in little quantities. So, these nutrients must be provided by other foods such as fish, therefore, the contribution of fish to food and nutrition security in Nigeria cannot be overestimated.

However, Nigeria national fishery products supply falls short of the demand. Based on continuous increase in aquaculture's contribution to the total fish production, then can the profit in aquaculture production sustain the growth in aquaculture business overtime? Also, what are factors influencing operational efficiency in aquaculture enterprise and what are the main limitations to fish farming enterprise in the area of study?

Therefore, the manuscript identified the socio-economic characteristics of aquaculture fish farmers, established the cost-effectiveness of fish production, evaluated how efficient the fish farmers are in their use of resources, ascertained the variables inducing the efficient use of resources and established the major limitations encountered by the owner and manager of fish farm enterprise in the area of study.

MATERIALS AND METHODS

Study area, source of data, sample techniques and size

A multi-stage selection method was employed for the research. Southwest Nigeria was randomly selected. Three states namely Lagos, Ogun and Ondo State were intentionally sampled because the three states account for 65.9% of aquaculture fish production in Southwest Nigeria[20], from each state; two Local Government Areas (LGAs) that are known for aquaculture fish production were deliberately chosen for the research. In each LGA, three communities that are known for aquaculture fish production were selected for the study and in each community, ten aquaculture fish farmers were selected for the research. So, the total number of respondents for the research was 180 aquaculture fish farmers.

Sample Analysis

Various investigative approaches were used to evaluate the data collected from the respondents. The demographic characteristics of the respondents were evaluated using descriptive statistics. The cost-effectiveness of the fish farmers and how efficient they are in their operation of fish farm enterprise were ascertained with Net Profit Margin Ratio (NPMR). The NPMR is **estimated with equation 1:**

$$NI = TR - TC \quad (1)$$

$$NPMR = \frac{NI}{TR} \times 100 \quad (2)$$

The Operating Expense Ratio (OER) was used to ascertain how efficient the aquaculture fish farmers are at keeping operating costs low while also earning revenue or making sales. The operating cost ratio is calculated thus:

$$\textbf{OER} = \frac{TVCTVC}{TR\ TR} \quad \textbf{(3)}$$

Fixed Cost Ratio (FCR) was employed to determine the ability of the aquaculture fish farmers to improve their profit margins, financial sustainability and the economies of scale of the aquaculture fish farm business. The fixed cost ratio is calculated thus**:**

$$\textbf{FCR} = \frac{TFCTFC}{TC\ TC} \quad \textbf{(4)}$$

where:
NI = Net Income
TR = Total Revenue
TVC = Total Variable Cost.
TFC = Total Fixed Cost
TC = Total Cost (TVC + TFC)

Efficiency model was employed to determine the variables influencing the aquaculture fish farmers' operational efficiency in the area of study. The model is specified as:

$$U_{ij}\,U_{ij} = \delta_0\delta_0 + \delta_1\omega_1\delta_1\omega_1 + \delta_2\omega_2\delta_2\omega_2 + \delta_3\omega_3\delta_3\omega_3 + \delta_4\omega_4\delta_4\omega_4 + \text{----------} + \delta_n\omega_n\delta_n\omega_n + \mu \quad (5)$$

$U_{ij}\,U_{ij}$ = operational efficiency of the ith aquaculture fish farmer and jth observation of the aquaculture fish farmer.
where:
$\omega_1\omega_1$ = Age (years)
$\omega_2\omega_2$ = Age^2 (years)
$\omega_3\omega_3$ = Gender (1 = male; 0 = female)
$\omega_4\omega_4$ = Marital Status (married = 1 and 0, otherwise)
$\omega_5\omega_5$ = Educational level (years)
$\omega_6\omega_6$ = Aquaculture fish farming experience (years)
$\omega_7\omega_7$ = Pond size (Cubic meter)
$\omega_8\omega_8$ = Family labour (man day)
$\omega_9\omega_9$ = Hired labour (man day)
$\omega_{10}\omega_{10}$ = Access to credit (yes = 1,otherwise = 0)
$\omega_{11}\omega_{11}$ = Household size (number)
$\omega_{12}\omega_{12}$ = Association/Cooperative membership (yes = 1, otherwise = 0)
$\omega_{13}\omega_{13}$=Access to extension agents
$\delta_0\delta_0$= Constant
$\delta_1\delta_1 - \delta_n\delta_n$ = Unknown parameters to be estimated
μ = Error term

In order to analyse and determine the important constraints faced by aquaculture fish farmers in the area of study, 4-points Likert Rating Scale (LRS) was used to expound how crucial the constraints were to the aquaculture fish farmers in the area. The 4-point LRS ranges from 1 to 4 (i.e. Very serious, serious, mild and not serious). Relative Important Index (RII) was used to ascertain the crucial constraints. The RII equation is as follows:

$$\text{RII} = \frac{\varepsilon W \varepsilon W}{AN\,AN} \quad (6)$$

where:
W is the weighting given to each problem by respondents (1 to 4)
A is the highest weight (4 in this case)
N is the total number of respondents.
RII ranges between 0 and 1, the higher the value the more important the constraint. 0.70 and above was considered as important constraints.

RESULTS AND DISCUSSIONS

Summary of statistics

Socioeconomic Characteristics

Table 1 presents the demographic result of the respondents. As shown in the Table, majority of the respondents were in their economic productive age as revealed by their average age of 36 years. Hence, they are very energetic and have the vigour to carry out the expected chore required in aquaculture fish farming. This is line with the findings of [11] that fish farming enterprise is highly laborious, hence, those who will be involved in such enterprise must be in their economic active age. This probably account for the reason why the enterprise is male dominated especially in most developing countries like Nigeria. Therefore, since majority of the respondents are in their productive economic age, their productivity will be enhanced because they will be able to optimise their strength in production of fish. The interviewed fish farmers are highly educated as shown in the Table where 92.1% of the respondents had Higher Institution Education (HIE) (Bachelor degree or equivalent). Appropriation of knowledge through training, seminars and workshop will

be enhanced. Such can make better use of research findings and apply knowledge gained from reading scientific journals and articles on how best to improve aquaculture fish production. This supports the assertion of [24], that the correlation between educated farmers and their productivity is high. The more educated a farmer is, the higher his/her productivity.

The household size of the respondents was four (4). Household size is very important to farmers in Africa, the contribution of family labour to farm work is a function of the household number, because the cost of labour is often high and beyond the reach of the peasant farmers [7]. Therefore, most of the respondents will probably result to using hired labour for their aquaculture fish farming since the household size is small (four). Regarding marital status, 76.1% of the aquaculture fish farmers were married. There is likelihood of husband and wife involvement in the farming business. In most cases, the woman will often involve in value addition, such as smoking and packaging to sell. Thus, the production aspect of the value chain lies within the purview of the husband, and the value addition and marketing aspect lies within the purview of the wife. This buttresses the findings of [39], that the value chain (i.e. production, processing, packaging and marketing) of agricultural produce in most developing countries revolve within the family since they are peasant farmers who cannot produce on large scale because of lack of finance and technology.

More than 88% of the respondents had less or equal 13 years farming experience, with mean fish farm experience of 12.9 years. This presupposes that the respondents are not novice in the business of aquaculture fish farming. Therefore, they are knowledgeable in the act of aquaculture fish farming. As the case in India, [33], posited that the more experience a farmer is in farming, the more knowledgeable he/she will be in the act. So, the more his/her productivity, because farming is an act that requires mastery overtime. The mean pond size of 1,125m^{3}of the respondents shows that they are small scale aquaculture fish farmers according to [38]. Most aquaculture fish farmers in the Southwest of Nigeria are small scale fish farmers unlike their counterparts in the South-south Nigeria. Above 92% of the respondents are member of an association or cooperative society. This is a good development, it enhances their access to pricing and marketing information, credit facilities and extension agents. This is one of the key benefits of belonging to an association or cooperative organization as the case of dairy marketing in the United States [17].

Table 1. Aquaculture fish farmers' demographic characteristics

	Aquaculture Fish Farmers' Key Socioeconomic Characteristic Values	
	Mean	**Dominant Indicator**
Age	35.8	86.2% falls below or equals 40 years (active)
Gender		87.8% were male
Education Level		91.2% had Higher Institution education (B.sc/HND)
Household Size (Number)	4	93.2% between 1and 5 persons
Marital Status		76.1% married
Fish Farming Experience (Years)	12.9	88.2% less or equal 13 years
Pond Size (Square M^2)	1,125m^3	91.5% had more than or equal to 1,120m^3
Membership of Cooperative/Association		92.2% belong to cooperative society or association

Source: Author's estimations based on data from survey 2023.

Estimation of Profitability and Operational Efficiency of Aquaculture Fish Production of the Area of Study

Table 2 presents the costs and returns of table size aquaculture fish production of the area of study. From the Table, the average Total Revenue (TR) of respondents was ₦19,704,600 ($25,425.29). The average quantity of fish sold by the respondents was 9,612kg fish per annum in two cycles. The average price of 1kg fish in the area of study was ₦2050($2.65) from the aquaculture farmers (farm gate). The average amount of feeds used by the farmers was 24 tons per

annum. The feeds cost is the most crucial cost in fish production accounting for 60.09% of the Total Cost (TC). This buttresses the assertion of United State Agricultural Department (USAD)that feeds cost is between 60% and 70% production cost of table size aquaculture fish [27]. Most of the respondents explained that they use allerqua for a start, blue crown for the grower stage and eco float for the last state. Some of the ingredients used in the production of the feeds are imported and the average price per bag was ₦19,250 ($24.84). There was about 100% increase in the price of feeds around June 2023. This was because the Central Bank of Nigeria (CBN) merged all segments of the foreign exchange market collapsing all windows into one. This was part of a series of immediate changes to operations in the Nigerian Foreign Exchange (FX) Market, in a bid to improve liquidity and stability [3]. In Nigeria, there were two windows to access dollars, pounds and euros which are black market and from CBN which is regarded as official. This led to increase in the price of the feeds and is impacting negatively on the production cost of aquaculture fish in Nigeria.

The average costs of labour according to the respondents was ₦4,250,000 ($5,483.87) accounting for 27.64% of the Total Cost (TC). The Federal Government of Nigeria (FGN) announced the removal of fuel subsidy in Nigeria. This led to increase in prices of goods and services which has led to increase in cost of labour in Nigeria. According to [40], cost of labour often fluctuates in less develop countries because of lack of stable economy policies. Therefore, cost of production of goods and services often become unpredictable. The Total Variables Costs (TVCs) which is the operating cost was ₦14,336,800 ($18,499.10) which accounted for 93.23% of the total cost of production of aquaculture fish in the area of study. Minimal operating expense ratio is better for an enterprise; it shows that expenses of such enterprise is reduced compared to the sales. Costs incurred by such enterprise are minimal and more efficient [2]. So, 72.76% operating expense ratio by the respondents is high and shows inefficiency of fish farm enterprise in the area of study. According to [18], lower operating expense ratio below 50% shows a good sign of higher efficiency which is optimal. An increasing operating expense ratio over time may indicate increasing expenses compared to Total Revenue (TR).

The Total Fixed Cost (TFC) which includes depreciation and cost of renting pond was ₦1,041,400 ($1,343.74) and accounted for 5.29% of the total cost of aquaculture fish production. Therefore, fixed cost ratio of the fish farm enterprise was 5.29%. This is low (below 20%) showing that the fish farm enterprise has minimal operating leverage. So, the fish farm enterprise profitability will be impaired even when the volume of sales increases, because variable costs, or other costs that depend on the number of units sold, increase with volume of sales [16]. The Gross Margin (GM) of the fish farm enterprise was ₦5,367,800 ($6,926.19) and the Net Income (NI) was ₦4,326,400 ($5,582.45). This supports the findings of [37]that fish farm enterprise is lucrative in the Southwest, Nigeria. Since majority of the fish farmers interviewed are on different economic scale of production, so, on the average, aquaculture fish farming was profitable.

To determine the productivity of capital employed and operational efficiency, profitability analysis is one of the best techniques. Therefore, Net Profit Margin Ratio (NPMR) was calculated as it shows the holistic representation of business profitability, returns on investment for any business and allows two or more businesses to be compared over a period. The higher the net profit margin ratio, the better would be the operational efficiency of the aquaculture production. A higher net profit margin ratio means that the business has been able not only to increase its sales but also been able to cut down its operating expenses. About 21.96% Net Profit Margin Ratio (NPMR) of the aquaculture fish farmers in the area of study implies that the fish farmers were not operating at their optimum expected minimum 25% of NPMR of any efficient business [2].This corroborates the findings of [18] that an operational efficient business is expected to make a minimum of 25% NPMR to ensure sustainability.

Table 2. Average estimated costs and returns of aquaculture fish production per year

Item of Cost	**Quantity**	**Unit Cost** ₦	**Total Revenue** ₦/$	
A. Revenue Quantity of fish sold	9,612kg	2050/kg	**19,704,600** **25,425.29**	
Item of Cost	**Quantity**	**Unit Cost** ₦	**Total Cost** ₦ $	**% of TC**
B. Variable cost				
Brood stock male & female	2	22,000	44,000 56.77	0.29
Feeds	24 tons	450,000 per ton @ 19,250 per bag	9,240,000 11,922.58	60.09
Labour			4,250,000 5,483.87	27.64
Ovaprim, Syringe, Saline Solution			65,000 83.87	0.42
Cost of Managing Hatchery (Electricity)			387,350 499.81	2.52
Tax and Levy			350,450 452.19	2.28
Total Variable Costs (TVC)			**14,336,800** **18,499.10**	93.23
Gross Margin (GM)			**5,367,800** **6,926.19**	
C. Fixed cost				
Depreciation (ponds/equipment)			785,650 1,013.74	5.11
Cost of Renting Pond			255,750 330.00	1.66
Total Fixed Cost (TFC)			**1,041,400** **1,795.94**	6.77
Total Costs (TC) (B+C)			**15,378,200** **19,842.84**	
Net Income **C - (A+B)** **Net Profit Margin Ratio =NI/TR x 100** **Operating Expense Ratio = TVC/TR** **Fixed Cost Ratio = TFC/TR**			**4,326,400** **5,582.45** **21.96%** **72.76%** **5.29%**	

Note: $1 = ₦775 official Central Bank of Nigeria (CBN) rate
Source: Author's estimations based on data from survey 2023.

Estimate Results of Factors Influencing Operation Efficiency of Aquaculture Fish Production in Area of Study

From Table 3, the value of R – square was 0.917 which implies that 91.7% of total variation in the operational efficiency of aquaculture fish production in the area of study was accounted for by all explanatory variables in the model while the remaining 8.3% was explained by the random error. The significance of F-value of 4.184 implies that all the explanatory variables jointly exerted significant influence on the operational efficiency of aquaculture fish production in the study area. The Table revealed that gender of the aquaculture fish farmers was positively significant (1% level of significant) to their operational efficiency. In the study carried out in Rwenzori region of Uganda, it was confirmed that most aquaculture fish farmers are male because fish farming requires strength and vigour [34]. So, in most cases, it is mostly dominated by young male as confirmed in Table 1 (86.8% were male and the mean age

was about 36 years). Aquaculture farming chore can best be handled by young male fish farmers who are energetic and can run around [26].Therefore, the higher the number of male fish farmers, the higher the operational efficiency of fish farm enterprise in the area of study.

The fish farmers' educational level was positive and significant (1% level of significance) to the operational efficiency. So, additional education of fish farmers will probably lead to additional increase in their operational efficiency. Findings in rural Vietnam revealed that there is positive correlation between the educational level and operational efficiency level of farmers [21]. An increase in the educational level of aquaculture fish farmers in the study area will lead to an increase in their operational efficiency. Most educated farmers operate on large scale economics, they can make better use of knowledge gained through reading, attending seminars and conference. They often harness the benefit of their education to access fund through grants, and writing feasibility study to access loan from financial institutions, government agencies and international donors. Therefore, educated farmers are often more productive than the uneducated farmers.

Fish farming experience was positively significant (1% level of significance), implying that the more experience aquaculture fish farmers are, the higher their operational efficiency. Aquaculture fish farming is an act that requires mastery over time [19]. As usual in agricultural production, the longer one is in the farming business, the more you learn the process and master it over time. Mastery of the agricultural production process reduces wastage, enhances good mix of agricultural inputs that give room for more yield and ensures operational efficiency. Pond size was positively significant (1% level of significance), increase in pond size will lead to increase in operational efficiency. So, aquaculture fish farmers with bigger pond size or more ponds, will be more operational efficient than those with small pond size. This buttress the finding of [25] in Ghana that most large-scale aquaculture fish farmers with large ponds size harnesses the benefit of economic of scale, so, they are more operationally efficient. They often take advantage of technology and infrastructure know-how to get the best out of the farming process.

Access to credit was positively significant (1% level of significance), implying that the more aquaculture fish farmers in the area of study has access to credit facilities like loan, grants and financial support from government, national and international Non-Governmental Organizations (NGOs), the more their operational efficiency. Therefore, having access to credit will lead to increase in their operational efficiency. Finance is very important in agricultural production, when money is available to buy the needed inputs as at when due, operational efficiency is enhanced. Most farmers in less developed countries lack access to finance, and in few cases when they have access to such finance, it is not timely and sufficient [30]. Financial institutions are often sceptical to give credit facilities to smallholder farmers because of lack of collateral and inability to provide a convincing feasibility study. However, large scale farmers have deed of title of their land to use as collateral and are able to pay for bankable feasibility study, hence, they often access credit facilities from financial institutions easily and in some cases receive aids in form of grants from national and international organizations.

Association/Cooperative membership made positive and significant (5% level of significance) contributions to the operational efficiency of aquaculture fish production in the area of study. Reflecting that the more aquaculture fish farmers join or belong to association or cooperative society the more their operational efficiency. Membership of an association or cooperative society enables the farmers to get more information like how best to get improved seedlings, new methods of production and how best to market their produce. The information enhances operational efficiency. The key factors that enhance operational efficiency in agricultural production are access to improved seedlings and cost saving method of production [35]. These can only be accessed through information from other co-farmers, hence,

membership of association and cooperative society will impact positively on aquaculture fish farmers' operational efficiency in the area of study. This buttresses the findings of [12], that if farmers can organize themselves to form an association or cooperative, they have a lot to benefit. Funding raising for agricultural purposes will be very easy, several national and international donors will be willing to give financial aid to them through the association or cooperative society.

Access to extension agents was positive and significantly (5% level of significance) influence the operational efficiency of the aquaculture fish farmers in the study area. This implies that the more access the aquaculture fish farmers in the study area have to extension agents, the more their operational efficiency. Extension agents are very important in the 21st century agricultural production. They provide critical information that will enhance farmer's operational efficiency. Such information includes how to access improve seedlings, how to mitigate risks, training on improved technique of production among others. Therefore, access to them equip farmers with inherent ability to achieve more productivity. [31] stated that any farmer ignoring the services of extension agents is doing that at his/her own disadvantage.

Table 3. Determinant of factors influencing efficiency of aquaculture fish production

Variables	Parameters	Coefficients	Standard Errors	T- values
Constant	δ_0	0.127	1.512	0.0839
Age	ω_1	-0.0107***	0.0022	4.864
Age^2	ω_2	-0.185	0.159	1.164
Gender	ω_3	0.0567***	0.01	5.67
Marital Status	ω_4	-0.326	0.725	0.450
Educational level	ω_5	0.241**	0.0989	2.437
Aquaculture fish farming experience	ω_6	0.202***	0.065	3.108
Pond size	ω_7	0.0688***	0.0195	3.528
Family labour	ω_8	0.138	0.447	0.309
Hired labour	ω_9	0.116	0.107	1.084
Access to credit	ω_{10}	0.0423**	0.0148	2.858
Household size	ω_{11}	0.0544	0.0359	1.515
Association/Cooperative membership	ω_{12}	0.0476**	0.0236	2.016
Access to extension agents	ω_{13}	0.06712 **	0.03308	2.029
R - Squares		0.917		
F-value Statistics		4.184***		

***Significant at 1%, **Significant at 5%, *Significant at 10%
Source: Author's estimations based on data from survey 2023.

Age of aquaculture fish farmers was negatively significant to their operational efficiency, which connotes that increase in the age of aquaculture fish farmer will lead to reduction in their operational efficiency. Therefore, the older an aquaculture fish farmer is, the lower his/her operational efficiency.

Estimate Results of Constraints Facing Aquaculture Fish Production

Table 4 revealed that the major limitation encountered by the fish farmers in the area of study was excessive cost of feeds with RII of 0.95.This supports the findings of [4]that instability in the price of feeds is one of the main problems affecting aquaculture fish production in Nigeria and other less developed countries. The cost of feeds accounts for more than 60% production cost even in the United State of America (USA). Therefore, any variation in such cost affects reasonably the variable costs which makes operation expenses unpredictable, making planning very difficult. The second critical problem facing the fish farmers was excessive cost of labour (0.93). Aquaculture fish farming is very herculean and requires energy and strength to execute it

successfully. Consequently, there is need for dedicated labour to be successful in the business. However, due to minimum wage policy of the Nigeria government and subsidy removal on fuel, the hired labour cost (wage) is now very high. According to [28], keeping a committed labour in farming activities requires good wages, because hired labour are highly mobile in less developed countries.

Insufficient fund (0.90) was the third serious constraint militating against the aquaculture fish farming in the area of study. Most smallholder aquaculture fish farmers were unable to procure the feeds as at when due, because there was sudden surge in the price of feeds and labour. They could not approach any financial institution for credit facilities, thus, they had serious problem in their production process. Aquaculture fish farming require adequate and timely fund, if not, the expected operation efficiency will not be achieved [14].

Absence of structural market (0.88) is the fourth major constraints hindering smooth aquaculture fish farming in the area of study. Due to lack of structure market, the middlemen often exploit the fish farmers. They often buy from them at the farm gate price which is very low and they sell at higher price to the Hotels, Eateries and final consumers. Therefore, there is need for standardization aquaculture fish price that will ensure that farmers are not short-changed by the middlemen. In agricultural production value chain, middlemen often benefit more than the farmers who are the producers [9]. This is due to lack of agricultural produce price control that will benefit the farmers.

Lack of better-quality seeds (Fingerlings and Juveniles) (0.83) was the fifth constraint militating against the aquaculture fish farmers in the area of study. At the initial stage, it is very difficult to know if fingerlings or the juveniles procured were actually improved seedling or not. Until they start to grow that the fish farmers often detect that the fingerlings and the juveniles are not growing as expected even when they are well fed. This often leads to waste of money and resources as explained by the fish farmers. This buttresses the findings of [32] in Tanzania, that fish seed market in developing countries is like a black-market that fish farmers are not sure of what they are buying.

Insufficient technical management of pond (0.72)is another major problem militating against the aquaculture fish farmers in the area of study. Pond management require some technicalities, especially the modern fiber ponds.

Table 4. Distribution by Rank of Constraints Faced by Aquaculture Fish Farmers

Constraints	**Very serious (4)**		**Serious (3)**		**Mild (2)**		**Not at all (1)**		**RII**	**Rank**
	Freq	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**		**1st**
Excessive cost of feeds	143	79.4	37	20.6	0	0	0	0	**0.95**	**2nd**
Excessive cost of labour	127	70.6	53	29.4	0	0	0	0	**0.93**	**3rd**
Insufficient fund	112	62.2	65	36.1	3	1.7	0	0	**0.90**	**4th**
Absence of structural market	112	62.2	47	26.1	20	11.1	1	0.6	**0.88**	**5th**
Lack of better-quality seeds (Fingerlings and Juveniles)	60	33.3	117	65.0	0	0	3	1.7	**0.83**	**6th**
Insufficient technical management of pond	52	28.9	72	40.0	36	20.0	20	11.1	**0.72**	**7th**
Frail extension support	49	27.2	70	38.9	33	18.3	28	15.6	**0.70**	**8th**

Source: Authors' estimations based on data from survey 2023.

Earthen pond is going out of vogue in the area of study, most of the fish farmers are using fiber pond. Hence, there is need for technical knowledge of how best to manage the pond to achieve optimal production.

According to [32] pond management is very important to optimal efficiency of fish farmers.

Frail extension support (0.70) is another very important constraint to aquaculture fish farmer's productivity in the area of study. Most smallholder farmers cannot pay for the services of the extension agents; hence, they do not benefit from their expertise. Extension agents are very important in all agricultural

production process, they train the farmers on good agricultural practices, they demonstrate to them modern and improved method of production, supply farmers with information on how to mitigate risk among others [13].

CONCLUSIONS

The study evaluated the aquaculture fish farmers profitability, their operational efficiency, factors influencing their operational efficiency and determined the important constraints faced by aquaculture fish farmers in southwest, Nigeria. Using net profit margin ratio**, operating expense ratio, fixed cost ratio,**efficiency model and relative important index, the study revealed that aquaculture fish farming is profitable but inefficient in the area of study. Though government at various levels (Federal, State and Local Government Area (LGA) have put in place a lot of schemes to encourage fish farm enterprise in Nigeria and other less developed countries of the world. No concrete research to support the fish farm enterprise operational performance over the years in Nigeria and other emerging countries of the world. Therefore, the research findings will provide other scholars the needed insight into the fish farm enterprise operational performance in Nigeria. The findings will add to the existing knowledge on cost-effectiveness of aquaculture fish farmers in the study area, how efficient the fish farmers are in their operation of fish farm enterprise, ascertain the variables inducing the efficiency of their operation of fish farm enterprise and establish the major limitations encountered by the owner and manager of fish farm enterprise in the area of study. Findings from the research suggest that there is need for the government and international organizations to create educational awareness among the aquaculture fish farmers in the area of study. Also, to encourage them to belong to an association/cooperative society. Likewise, there is need to enlighten the fish farmers in the area of study to embrace the services of the extension agents. Again, government should introduce subsidy policy in fish farm enterprise of the agricultural sub-sector of the economy. This will help in reducing the price of feeds.

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