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NIGERIAN JOURNAL OF AGRICULTURE, FOOD AND ENVIRONMENT

Volume 15	2019	Number 3

Pages *TABLE OF CONTENTS*

1-10	Studies on incidence and effects of temperature and relative humidity on post harvest rot of cocoyam (*Colocasia esculenta*) in Gombe community, Gombe State, Nigeria. **Baba A, Igwillo U.C, Abdullahi M.M, Ikhiboya F.I, Nwokeke C.C, and Ihekorom, C.**
11-14	Effect of farm yard manure on cucumber *(Cucumis sativus* L.*)* growth performance in Dadin-Kowa, Nigeria. **Mahmoud, B. A. and Wakili, A.**
15-22	Population ecology of plants conserved in homegarden of Oruk Anam local government area, Akwa Ibom State, Nigeria. **Eric, E. E., Udofia S. I. and Ejizu, A. N.**
23-30	Assessment of cyanogenic glycoside content in cassava (*Manihot esculenta, Crantz*) grit (garri) sold in Aba, southeastern Nigeria. **Umezuruike, S. O. and Ubuoh, E. A.**
31-35	Adaptive measures adopted in reducing flood hazards by residents of Uyo urban, Akwa Ibom State, Nigeria. **Etuk, U. R., Harrison, U. E. and Aquatang, S. M.**
36-42	Perceived health implications of abattoir activities on residential neighborhoods: a case study of Bodija Abattoir, Ibadan, Nigeria. **Ajanaku A. O., Oyelami B. A., Eniola, O. and Ugege B. H.**
43-52	Effect of water-washing on chemical composition and *in vitro* biogas production of west african dwarf rams offered diets containing water-washed neem (*Azadirachta indica*) fruit. **Jack, A. A.**
53-57	Diversity and population structure of woody species in Mbad Akan sacred forest of Nsit Ubium local government, Akwa Ibom State, Nigeria. **Ekpa, N. E, and Ntia, N. M.**
58-62	Effect of irrigation intervals and spacing on the growth and yield of sweet pepper (*Capsicum annum L*) in Dadinkowa, Gombe State. **Wakili, A. and Mahmoud, B. A.**
63-71	Determinants analysis of protein consumption among households in Uyo capital city, Akwa Ibom State, Nigeria. **Obot, O. J., Okoroafor, R. C. and Esin, C. T.**
72-77	Haemoglobin genotype and gene frequency of indigenous chickens in the rain forest zone of southwestern Nigeria. **Imouokhome, J. I., Orheruata, A. M. and Oyedeji, J. O.**
78-83	Nutritive value of sweet potato vines ensiled with caged layer droppings. Ukanwoko, **A. I. and Igbokwe, G. A.**
84-93	Technical efficiency differentials in aquaculture resource use among selected fish farms in Kaduna State, Nigeria. **Awolumate, S. and Inyang, E. B.**
94-101	Aerobic bacteria flora associated with freshwater apple snail *(Pila ampullaceal)* in Kolo Creek, Ogbia, Bayelsa State. **Opara, C. N and Okpe, C U.**

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TECHNICAL EFFICIENCY DIFFERENTIALS IN AQUACULTURE RESOURCE USE AMONG SELECTED FISH FARMS IN KADUNA STATE, NIGERIA

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ABSTRACT
This study examined fish farm characteristics and technical efficiency of selected fish farm in Kaduna State, Nigeria. A well-structured questionnaire was used to obtain primary data. The simple random sampling technique was used to select seventy-five respondents drawn from the list of Agricultural Development Programme (ADP) contact farmers in three Local Governments Areas (Chikun, Igabi and Kaduna North). Descriptive statistics were used to analyze the socioeconomic characteristics of fish farmers while stochastic frontier production function analysis was used to determine the technical efficiency of the farmers. The results showed that majority of the respondents (74.7%) were married males. 45.3 percent of farmers are within the age of 31-40 years. 50.7 percent had about 5 years' experience in fish farming. 69.3 percent went through tertiary education. 40 percent of the fish farmers have household size of 4 – 6. A large proportion (42.70%) of the fish farmers are civil servant. 42.7 percent of fish farmers' objective was to make profit. Coefficient of feeds and fertilizer are positive and statistically significant, while, fish farmers' experience and education positively influence technical efficiency by 13% and 28% respectively. The mean efficiency value was 0.901 with majority (70.67 %) of the fish farmers being over 90 percent efficient and about 29.33 % having technical efficiency ranging from 50 to 90 percent.

Keywords: Technical, Efficiency, Aquaculture, Fish farm, Differentials.

INTRODUCTION
Nigeria is considered the largest aquaculture fish producer in sub-Saharan Africa, accounting for 54 percent of the total fish production in the sub-region. Nigeria's aquaculture focuses mainly on freshwater fishes, with catfish species accounting for 64 percent of the country's aquaculture production in 2015 (FAO, 2017). F.A.O further showed that Nigeria's fish trade deficit increased from 350 thousand tonnes to nearly 2 million tonnes between 2000 and 2011 before declining to 940 thousand tonnes in 2013. Fish production in Nigeria grew from 260 000 tonnes in 1980 to over 1 million tonnes in 2015. While capture fisheries is still the main source of fish production in the country, the share of aquaculture has increased from 2 percent in 1980 to over 30 percent in 2015 (FAO, 2017). Nigeria's fish demand in the early 2020s is estimated to be 600 000 tonnes higher than the level in the mid-2010s because of income and population growth in the country. According to FAO (2017), aquaculture in Nigeria would require to grow at 22 percent a year from the mid- 2010s to the early 2020s in order to bridge the potential demand- supply gap. Unfortunately, the sluggish pace of the agricultural sector in Nigeria cannot meet with the rapid population growth rate resulting in fish shortfall. The objective of this study was to analyze the technical efficiency of fish farmers and describe its variability by fish farm characteristics in Kaduna State, Nigeria. Also, the study sought to identify factors influencing farm level inefficiency among the farms surveyed in the study.

The emergence of aquaculture epitomized the novelty of human creativity in achieving fish supply adequacy, this herald the transition from wild captures to an intensive fisheries culturing, where a milestone was reach in 2014 when aquaculture sector's contribution to the supply of fish for human consumption overtook that of wild-caught fish for the first time (FAO 2016). Fish farming, is quite strategic in driving economic inclusiveness, by engaging economically and socially disadvantage segments of the society due to its vast economic value chain activities also, serving as an important source of food/nutrition for millions of people globally (Viswanathan et al, 2003). The vigorous growth in aquaculture aids the world per capita fish supply to reached a peak of 20 kg in 2014, and contributes

about 47% to global fish supply chain in 2016, it first sale value estimated at 243.5 billion USD (FOA, 2018) thus projecting aquaculture as a viable investment option.

In Nigeria, aquaculture is private sector driven, the investments is visible in feeds, seeds (fingerling) and fish rearing perhaps aiding the country to command a place of pride in aquaculture fisheries production in sub-saharan Africa. Nigeria is the largest aquaculture producer in the sub-Saharan Africa and this sector output has grown steadily to 316700 tonnes in 2015 with catfish being the most farmed species grown in ponds and tanks (FAO, 2017). The contribution of aquaculture to the country's fish production stood at 31 percent, while marine catches and inland water catches records 36 and 33 percent respectively culminating to 1027000 tonnes of fish output in 2015 (FAO, 2017). Despite this feat, fish demand based on 2014 population estimate of 180 million people is reported to be at 3.32million metric tonnes, according to Nigerian fisheries statistics report (2016), with domestic output from aquaculture, artisanal and industrial fisheries for 2014 stood at 1.123 million tonnes, leaving about 2.21 million as deficit, thus making fish importation an inevitable option. Irrespective of fish production data variations from the afore mention sources, the reality is that the country's fisheries production level is sub-optimal relative to the fish demand gap (FAO, 2015), report highlighted that aquaculture fisheries would require to grow at 22% per year from mid-2010s to early 2020 to bridge demand-supply gap since early 2020s demand will rise to 600000 tonnes higher than the mid-2010s due to income and population growth in the country. Reverting the domestic fish supply (production) deficit trend will entail more investment in aquaculture fish production, which has a positive profitability outlook. Plethora of studies attest to this fact, Awolumate and Inyang (2019) Misra and Misra (2014), Samson and Adeoye (2012), Sharma, Leung, Chan and Peterson(1999) and Signh and Kumar (2015) buttressed this assertion when measuring the profitability of small scale aquaculture enterprises in South West Nigeria by adopting enterprise budget analysis to analyze economics of fish farming, in determining the possibility of making money generally from such business activity, also using simple profit/loss calculation in determining the profitability of the business. The result revealed that fish farming was viable since BCR(benefit cost ratio) was greater than one, and profitable with the net return on investment of 1.05 implying that for every one naira invested, ₦1.05 was gained although not profitable enough. The study further showed that 25% of firms operated profitably while 75% were not, and highlighted high price of feed and high mortality of stocked fish as the most serious constraints. In a similar study by Inoni, Ogisi and Achoja (2017) on profitability and technical efficiency in homestead catfish production in Delta State, Nigeria; net margin-total cost ratio was used to ascertain the level of profitability of catfish farming at homestead level. The ratio was 0.29 implying that the investment earned as high as 29% return on capital invested, meaning that 100 kobo invested by the farmer gained 29 kobo as profit suggesting that homestead catfish production was profitable in the study area. The low profitability margin or ratio as highlighted above could be attributed to the prevailing constraints or operational inefficiency, although constraints may vary subject to the country's ecological regions but could be broadly viewed or classified broadly into Economic, Technical and Policy framework. Economic constraints centeron challenges of sourcing for operational and investment capital at low cost for business financial sustainability and expansion, while technical constraints; boarders on skilled knowledge gap in fish rearing (production), processing and marketing and the policy framework constraints; focuses on governmental programmes towards enhancing the sub-sector through extension service coverage, research, financial intermediation or subsidies and physical infrastructure provision.

Mitigating technical constraints is pertinent due to it significant role in fish farming; being capital and management intensive by nature would necessitate a skilled managerial capacity (competency) to drive operational efficiency towards enhancing aquaculture firm objectives of output maximization and profit maximization. Output maximization entails efficiency in production, which is a critical challenge amongst aquaculture firms. Ayyappan and Gopalakrishann (2008) and Kumar and Engle (2017) assert that production performance of aquaculture sector has followed an uneven path and a large gap exists in productivity and efficiency. Thus, creating the suspicion of under-utilization of resources, argued to debacle the meeting of fish demand target for the country. However, the realization of fish supply (production) sufficiency lies in firms striking that balance between productivity and efficiency which implies attaining technical efficiency. Technical efficiency represent the ability of a firm (aquaculture) to produce maximum output given a set of inputs and technology (output oriented) or, alternatively, to achieve maximum feasible reductions in input quantities given the input prices and output (input-oriented), thereby producing output optimally, Farrel (1957). Findings by Inoni, *et al* (2017) on technical efficiency homestead catfish production in Delta State, Nigeria; using maximum likelihood estimates of

the stochastic production function , reveals that all the independent variables; pond size, feeds, fingerlings and labour exerted positive and statistically significant effects on fish output in homestead catfish production. The technical efficiency (TE) of homestead catfish firms ranged from 28% to 96% with an average of 87%. Further analysis of the study indicated that household sized had a positive and significant influence on inefficiency, while age of the farmer, level of formal education and access to credit had negative and significant effects on inefficiency. The return to scale value was 2.24 implying increased return to scale and that homestead fish production was within stage 1 of the total production curve. Indicating that catfish production holds great potentials for increased productivity. A similar study by Singh and Kumar (2015) in Punjab, India on profitability and technical efficiency of aquaculture showed that stocking density and feed were significant at 1% level, indicating that 1% increase in stocking density would result in change in output by 0.24%, keeping all other variables constant. While a 1% increase in feed would result in change in output by 0.08%. 96% was the difference between the observed and the frontier output. The average technical efficiency of the aquaculture-farms was 78% compared to the best frontier whereas the allocative efficiency was 58%. The economic efficiency of Punjab farmers in aquaculture was recorded around 45%. The study revealed that although the farms were technically sound, the economic efficiency was low, sighting reasons such as inefficient use of resources, low price of output or high cost of inputs. The distribution of farms according to efficiency showed that, nearly two-fifths and one-fifth aquaculture-farms had less than 70% and between 70-80% technical efficiency respectively and 41% farms had shown more than 80% efficiency when compared with the best frontier, and that small fish farmers were managing their resources better than the other category of farmers. Owing to the financial constraints of fish farmers (aquaculture firms), they would tend to be more Input-oriented in attaining efficiency. Hence, Inputs-oriented (DEA; data envelopment analysis model) approach of technical efficiency seems appropriate, given the fact that aquaculture firms have more control over inputs than output levels (Sharma et al, 1999 and Kumar, Engle and Tucker, 2016), in this wise, Misra and Misra (2014) used meta-frontier-data envelopment analysis (DEA) model to calculate the frontier production function of a set of decision-making units (DMUs). In meta-frontier analysis, the performance of each individual fish farm in the sample is measured against two different frontiers; one based on farms from all the different groups in the sample and the other based only on farms from the group to which it belongs. Where, the first can be regarded as the grand frontier and other as the group frontier. The study observed that a wide variations in the level of technical efficiency scores among the sample farms, that more than 60% of the sample farms were operating below the average level of technical efficiency and that it might be due to the mismanagement regarding input mix. That a reduction of 30% Input- use is possible for farms to maintain their existing level of production.

Aquaculture fish farming has been an integral aspect (part) of agriculture in the study area, the assessment or ascertaining of what ought to be the optimum output level amongst aquaculture firms, subject to their resources or characteristic requires or demands critical evaluation. Hence, the interest (quest) to assess the technical efficiency differentials amongst aquaculture firms in Kaduna State, Nigeria.

METHODOLOGY

The study was conducted in the metropolis of Kaduna (a City in North Western Nigeria) capital of Kaduna State. Kaduna State is comprised of 23 Local Government Areas with a total land area of about 46,053 km^2 and an estimated population of 6,066,562. Kaduna State is mostly populated by Hausa, Gwari, Katab and Banjjuu ethnic communities. The State is bordered by Sokoto, Katsina, and Kano States to the North, Bauchi to the East, Plateau to the East and South, Niger to the West and Abuja (FCT) to the South. Local Government Areas (LGAs) selected in Kaduna metropolis for the study includes: Chikun, Igabi and Kaduna North. The simple random sampling technique was used to select 75 respondents from the list of Agricultural Development Project (ADP) contact farmers in the study areas. Twenty-five (25) fish farmers were selected at random from Chikun, Igabi and Kaduna North LGAs. The data for the study were collected between March 2018 and August 2018, through well – structured questionnaire.

Stochastic Frontier Analysis (SFA) approach was employed to examine the efficiency of fish farmers in Kaduna State. SFA was introduced by Aigner, Lovell and Schmidt (1977) and Meeusen and Van den Broeck (1977). It is commonly employed in the study of farm level productivity, efficiency and inefficiency as well as their sources in agricultural production. Generally, Stochastic Frontier model is given as:

$$Y_i = f(X_j) + v_i - u_i$$

Where Y_i is the output of fish production of farmer i , X_j are the inputs j, j goes from 1 to n, v_i is the stochastic error term and u_i is the error that represents the technical inefficiency of farmer i.
The Cobb-Douglas form of the Stochastic Frontier production model given as;

$$lnY_i = \beta_{0+}\, \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \beta_5 lnX_5 + \beta_6 lnX_6 + \beta_7 lnX_7 + v_i - u_i$$

Where;

$X_1 = Feed,\ X_2 = Fertilizer,\ X_3 = Lime,\ X_4 = Labour,\ X_5 = Pond\ contruction,\ X_6 = Drug\ , X_7 = Fingerling.$

B_0 = constant

β_1..... β_7 = coefficients of the variables X_1 ....X_7 as defined in the fronter model

In the quest to know the factors that contribute to fish farmers' level of inefficiency, an inefficiency model was estimated alongside the stochastic frontier production function as;

$$u_i = \delta_{0+}\, \sigma_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7 + \phi_i$$

Where;

$Z_1 = Age,\ \ Z_2 = Gender,\ \ Z_3 = Year\ of\ experience,\ \ Z_4 = Household\ status,\ \ Z_5 = Educational\ status, Z_6 = Farm\ size\ , Z_7 = Stable\ market\ , \phi_i = error\ term.$

δ_0 = constant

δ_1..... δ_7 = coefficients of the variables X_1 ....X_7 as defined in the inefficiency model

A negative coefficient of any of the explanatory variables shows a decrease in inefficiency and increase in the explanatory variable. However, positive coefficient shows increase. Maximum Likelihood Estimation (MLE) is the estimation technique used in this study with the aid of the software program, FRONTIER (version 4.1c). The likelihood ratio (LR) statistic is used asses the validity of the model.

RESULTS AND DISCUSSION

Technical Efficiency of Fish Farming in the study area

The maximum likelihood estimates of the stochastic frontier production function and inefficiency models for fish farm in Kaduna state are presented in Table 1. The estimates for parameters of the stochastic frontier production function revealed that the coefficient of feeds and fertilizer are positive and statistically significant at 1% and 5% levels respectively. This implies that one percent increase in cost of feeds and fertilizer by the farmer contributed 0.278% and 0.035% increase in the output. This is consistent with Aktar et *al, (2018)* findings. However, drug was negatively significant at 1% level. This implies that the output of the fish farmers decline by 0.225% given one percent increase in drug.

The stochastic frontier production function of the inefficiency model revealed that fish farmers' experience and education positively influence technical efficiency by 13% and 28% respectively. This implies that as farmers become experienced and increase in level of education the Technical efficiency also increase. This is in tandem with Aktar *et al, (2018)* findings conversely, age of the farmers negatively influence technical efficiency. This implies that as farmers advance in age, technical efficiency reduces. This is contrary to Ogunmefu *et al* (2018) results.

Additionally, the coefficient of Farm size appears to be positive and weakly significant at 10% level. This is indicates that the farmers are unable to maximize their farm size. Finally, Gender, Household size and Market stability appears to be statistically insignificant. Onoja *et al, (2012)* got similar result.

The variation in the level of technical efficiency (sigma squared σ^2 coefficient) was 0.189 (18.9%). The technical inefficiency effects and factors beyond the control of fisher folks (Gamma coefficient γ) was 0.762 (76.2%). Log likelihood functions was -59.45.

Table 1: Parameter of the Cobb-Douglas Stochastic Frontier and Efficiency Model for Fish Harvesting in Rivers Niger and Benue

Symbol /Variable	Parameter	Coeff./ Elasticities	Std. Error	t-ratio
X_0 = Constant	β_0	7.245***	1.048	6.915
X_1 = Feed	β_1	0.278***	0.071	3.924
X_2 = Fertilizer	β_2	0.035**	0.014	2.457
X_3 = Lime	β_3	0.029	0.030	0.967
X_4 = Labour	β_4	0.224	0.327	0.684
X_5 = Pond Construction	β_5	0.219	0.433	0.506

X_6 = Drug	β_6	-0.225***	0.068	-3.312
X_7 = Fingerling	β_7	0.060	0.228	0.264
Inefficiency				
Z_0 = Constant	δ_0	0.364	1.655	0.220
Z_1 = Age	δ_1	0.208***	0.061	3.419
Z_2 = Gender	δ_2	0.045	0.425	0.107
Z_3 = Year of Experience	δ_3	-0.131**	0.055	-2.400
Z_4 = House hold Status	δ_4	[illegible]	[illegible]	[illegible]
Z_5 = Educational Status	δ_5	-0.280***	[illegible]	[illegible]
Z_6 = Farm Size	δ_6	0.379*	0.194	1.953
Z_7 = Stable Market		-0.194	0.318	-0.609
σ^2 = Sigma2		0.189***	0.057	3.335
γ = G amma		0.762***	0.153	4.997
Log likelihood function		**-59.452**		
LR test		**7.056**		

Source: Field Survey, 2019.
Note. ***Significant at 1%, **significant at 5%, *significant at 10%

Frequency Distribution for Technical Efficiency of Fish Farmers
The frequency distribution of the technical efficiency of the fish farmers in this study is presented in Table 2. From the result, the TE of the farmers hovers around 33.30% and 99.05 with an average value of 90.01%. This means that the fish farmer that is least efficient is 66.70% away from the expected production frontier, and the most technically efficient fish farmer is only 0.95% away from the expected production frontier. The computed average technical efficiency is 90.01% suggesting that an average farmer would have produced 9.99% more output with the same level of inputs if the farmers were to produce on the most technically efficient frontier. Additionally, only two (2.67%) of the farmers are in the technical efficiency category of less than 50. However, the average technical efficiency falls in the technical efficiency class of 11- 99 percent.

Table 2: Deciles Range of Frequency Distribution for Technical Efficiency of Fish Farmers

Technical Efficiency	**Frequency of farmers**	**% of farmers**
<=50	2	2.67
51-60	4	5.33
61-70	0	0
71-80	6	8
81-90	10	13.33
91-99	53	70.67
Total	75	100
Minimum TE	33.3	
Maximum TE	99.05	
Average TE	90.01	

Source: Field Survey, 2019

Mean Technical Efficiency Profiling by Socio-economic Characteristics of Fish Farmers
Table 3, presents the result of the descriptive analysis of the significant variation in technical efficiency by the socio-economic characteristics of the sampled farmers in the study area. The results on Item 1 shows that majority (45.3%) of farmers are within the age of 31-40 years. However, few (16.0%) of the farmers are less than 30 years in age. This suggested that youths that are in their productive ages are mostly involved in fish farming in the study area. The distribution pattern of the mean technical efficiency revealed that their fish farming technical efficiency increases as their age advances. Despite the corresponding increase in mean technical efficiency by age of farmers, the variation was not statistically significant, According to item 2, among all the famers, about 74.7% of the farmers are males while 25.3% are females. This literally means males are more involved in fish farming than the females in the study area. This may be due to the fact that fish farming is a herculean task which makes males to be more

involved. Despite, male dominance of the practice of fish farming, the female had a higher Technical efficiency than the male farmers which the mean difference was statistically significant at 90% level of probability. With regards to Item 3, 74.7% of the farmers are married, 20.0% are single while the remaining5.3% previously married categories. The variation in mean technical efficiency of the categories of marital status was not statistically significant. Those not currently in marriage had higher technical efficiency performance. The previously married farmers displayed a better performance e than those within single category of farmers. The frequency of the years of experience of the fish farmers decrease as the experience years increases such that 50.7%, 25.3%, 14.7% and 9.3% of the respondents have 1-5 years, 6-10years, 11-15years, and 16-20 years of experience respectively implying that most of the farmers have less than five (5) years of farming experience. Though the fish farming sector usually experience reverse farming population with increase in years of practice, the technical efficiency did not quite follow the pattern of the year of experience. Those fish farmers with years of experience between 10-15 years had the highest mean efficiency and were followed by those with 1-5 years of experience. Equally, despite their variation mean technical efficiency across the years of experience, the difference in mean technical efficiency was not statistically significant. With regards to the household size of the fish farmers, about 40.0% of them have their household size between 4-6 members and on the other extreme 9.3% have it to be more than 10members. It was expected that household size should influence the productivity of fish farmers since there would be adequate supply of labour. As shown on Item 5, the mean technical efficiency did not quite follow the ascending trend of household size as the variation was statistically significant 95% level of probability. However, household with sizes ranging from 1 to 9 persons displayed more than 90% technical efficiency than those household with more than 10 persons. Based on educational qualification as shown on Item 6, majority (69.3%) of the farmers has tertiary education and this is followed by secondary education with about 25.3% and primary education with 5.3%. educational status of farmers were expected to influence significantly the variation across the mean technical efficiency of each categories. however the non-statistical significance of the variation suggests the relatively substantial level of formal education they have acquired could have had substantial influence on the comprehension of the tailor-made instructions towards maximizing productivity in fish farming. Those who had one form of tertiary education or the other displayed the highest level of efficiency. As shown on Item 7, a large proportion (42.70%) of the fish farmers are Civil servant, 25.3% are traders, 18.24% are core farmers, 6.70% are into Crop/ Livestock farming and just about 1.30% are artisanal fisher men. This means that fish farming does not prevent the selected respondents from getting involved in other means of earning. There appear to be an underlying pattern of the complementary occupation tends to influence the mean technical efficiency of the fish farmers. Those involved in artisanal fishing, farming and trading were more than 90% technical efficient than those involved in the civil service and crop/livestock farming. Nevertheless, the variation across the various other occupation categories was not statistically significant. The result in Item 8 revealed that about 42.7% indicate profit making as their fish farm goal while 9.30% is for consumption and the remaining 48.0% are for both profit and consumption. But the productivity of this with primary intent of consumption only had the highest mean technical efficiency of 0.9684 over others categories.

Table 3: Distribution of Fish Farmers based on Mean Technical Efficiency Profiling by Socio-economic characteristics

Item	Socio-economic Characteristics	Frequency	Percentage	Mean efficiency	F-value
1	**Age (Years)**				0.207 ^{NS}
	Less than 30	12	16	0.8726	
	31 to 40	34	45.3	0.9017	
	41 to 50	15	20	0.9049	
	Above 51	14	18.7	0.9144	
2	**Gender**				4.626**
	Male	56	74.7	0.8805	
	Female	19	25.3	0.9579	
3	**Marital Status**				1.060 ^{NS}
	Single	15	20	0.9341	
	Married	56	74.7	0.8868	
	Previously married	4	5.3	0.9584	

4	**Year of experience**				1.189 NS
	1 to 5	38	50.7	0.9184	
	6 to 10	19	25.3	0.8592	
	11 to 15	11	14.7	0.9334	
	16 to 20	7	9.3	0.8593	
5	**Household status**				2.477*
	1 to 3	26	34.7	0.9067	
	4 to 6	30	40	0.9043	
	7 to 9	12	16	0.9472	
	10 and above	7	9.3	0.7766	
6	**Educational Status**				1.505 NS
	No Formal Education	0	0	0.000	
	Primary School	4	5.3	0.8750	
	Secondary School	19	25.3	0.8556	
	Tertiary	52	69.3	0.9182	
7	**Other Occupation**				0.385 NS
	Civil servant	32	42.7	0.8802	
	Trading	19	25.3	0.9158	
	Crop/ Livestock farming	5	6.7	0.8905	
	Artisanal fishing	1	1.3	0.9905	
	Farming	18	24	0.9163	
8	**Goal of Production**				0.946 NS
	Profit	32	42.7	0.8903	
	Consumption	7	9.3	0.9684	
	Both	36	48	0.8955	

Note: (N=75) NS indicates Not significant, * indicates significance at 0.1 level of probability and ** indicates significance at 0.05 level of probability

Mean Technical Efficiency Profiling by Farm Characteristics

The results in Table 4 show the mean technical efficiency profiling according to farm characteristics of the farmers. Based on findings on Item 1, that majority (64.0%) of the farmers practice fish farming on less than 0.25hacters of land. The size of fish farm does not necessarily influence its technical efficiency. As the size increased, the mean technical efficiency did not follow any pattern. Those farms within the range of0.51 to 0.75ha exhibited the highest technical efficiency. Those within the farm size of less than 0.25ha also had over 90% technical efficiency. It can be asserted that none of the fish farmers had less than 80% technical efficiency. However, despite the variation across the farm size ranges, the farmer technical efficiency did not statistical significantly. With reference to Item 2, 42.7% of the fish farmers acquired their land through purchase while others had it through inheritance (25.3%) and 32% operated on Leased land. Farmers operating on inherited lands were more technically efficient than those operating on leased and purchase lands. Despite the variation in levels of efficiency across the methods of land acquisition for fish farming, the variation was not statistically significant.

With regards to sources of fingerlings to production as shown on item 3, majority (70.7%) of the fish farmers obtained their fingerlings from other farms while 29.3% obtained theirs through on-farm breeding. Furthermore, those that source fingerlings from other sources displayed a higher mean production efficiency compare to on-farm breeding. Despite the differential the mean difference was not statistically significant. Based on this results, on-farm breeder seems not to technically proficient in selection and breeding processes thereby affecting their overall production efficiency.

Majority (62.67%) of the respondents obtained their broodstock from on-farm, 36% obtained theirs from other pond owners, only 1.33% collected from rivers/streams. According to respondent, those sourced from hatchery are more likely to be healthier and disease free. This is supported by Obande and Solomon (2000) who observed that fingerlings sourced from hatcheries, have high rate of growth and may be diseased free.

Majority (68%) of the respondents sourced their funding from personal savings while family and friends account for 17.35% of sources of fund while very few (5.3%) obtained bank loan. The mean variation

across the different sources of funding depict that farm with formal credit sourcing were more sensitive towards maximizing their productivity in order to generate enough income to offset their loans. Equally, the farmers are so eager to recover their investment could have also influence the level of productivity at 90.40%. Despite the difference in the mean index, the variation were not statistically different across the funding sources.

With regards to item 6, about 65.3% of the respondents obtained credit facility of between ₦100,000.00 and ₦500,000.00, while 6.7% obtained above ₦500,000.00. The variation followed a positive association with level of productivity. Increase in credit facility led to increase in resource use efficiency. This result showed that efficiency of production increased with credit availability to fish farmers even though mean difference was not statistically significant. This agreed with the findings of Ogunmefun, *et al*. (2018).

With regards to market stability, majority (70.7%) farmer indicate that they have stable market, the farmers with positive perception of the fish marketing correspondingly had a superior mean efficiency suggest a good source of motivation to achieve high returns on investment.

The results further indicate that majority (81.3%) of the of the respondents cultured mud/catfish, 18.2% cultured Heteroclarias, 7.3% cultured tilapia fish while 1.8% cultured Heterobranchus. According to the respondents, majority cultured mud/catfish because of its high preference/marketability, resistant to harsh environmental condition and can survival even in running and stagnant water. This finding is in agreement with FAO's position (2000) that catfishes have a market value of two to three times that of Tilapia. Interestingly, across the species cultured, the Clarias and Carp farmers were more efficient in resource use and followed by the Clarias and Tilapia combination. Multiculture farms were most technically efficient than monoculture farms except Tilapia only farms.

Table 4: Farm characteristics

Item	Farm characteristics	Frequency	Percentage	Mean Efficiency	F-value
1	**Size of farm**				0.814 ^{NS}
	Less than 0.25 ha	48	64	0.9071	
	0.26 to 0.5ha	18	24	0.8661	
	0.51 to 0.75 ha	5	6.7	0.9682	
	Above 0.76 ha	4	5.3	0.8831	
2	**Method of land Acquisition**				1.882 ^{NS}
	Inherited	19	25.3	0.9512	
	Leased	24	32	0.8725	
	Purchased	32	42.7	0.8904	
3	**What sources are of fingerling**				1.512 ^{NS}
	Purchased from the other farms	53	70.7	0.9126	
	On – farm breeding	22	29.3	0.8696	
4	**Sources of brood stock**				0.235 ^{NS}
	Collection from the wild	1	1.33	0.8644	
	Purchased from the other farms	27	36	0.9142	
	On – farm breeding	47	62.67	0.8927	
5	**Source of finance**				0.160 ^{NS}
	Own saving	51	68	0.9049	
	Bank Loan	4	5.3	0.9239	
	Cooperatives	7	9.3	0.8780	
	Family & Friends	13	17.3	0.8856	
6	**Obtained credit facilities**				0.161 ^{NS}
	N50, 000 - N100, 000	21	42.7	0.8877	
	N100, 000 - N500, 000	49	65.3	0.9030	

	>N500, 000	5	6.7	0.9235	
7	**Stable market**				0.343 NS
	Yes	53	70.7	0.9061	
	No	22	29.3	0.8854	
8	**Species of fish cultured**				0.198 NS
	Clarias	61	81.3	0.8953	
	Tilapia	5	6.7	0.9220	
	Carp	2	2.7	0.8650	
	Clarias and Tilapia	6	8.0	0.9309	
	Clarias and Carp	1	1.3	0.9637	

Note: (N=75) NS indicates not significant

CONCLUSION

The quest to attain food security drives the novelty in aquaculture fish farming and this culminates to it discovery as a potent option for economic inclusiveness. But the challenge has been sustaining it output to meet demand due to the exponential population rate of the country. This makes technical efficiency a subject of interest /investigation amongst aquaculture firms in the study area. The study reveals TE as follows: minimum TE (33.3%), maximum TE (99.05%) and average TE (90.01). 70.67% of farms recorded TE at the range of 91-99.while 13.33% farms attain the average TE mark and the remaining 16% farms recorded minimum TE. Farm characteristic was not statistically significant. Technical inefficiency was revealed in drug, year of experience, household status, educational status and stable market. Furthermore, aside from Sex and household size of the fish farmers, other socioeconomics and farm level characteristics did not have any significant effect on the operational performance of fish farming in the study area.

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