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Resource use Efficiency among Rain-Fed and Non-Rainfed Catfish Farmers in South West and North Central Nigeria

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Abstract: Efficient use of resources has been identified as one of the major bane of catfish production in Nigeria. Thus, this study examined the resource use efficiency among rain-fed and non-rain-fed catfish production in South West (Oyo) and North Central (Kwara) in Nigeria. Well-structured questionnaire was used to obtained information from 289 farmers, 149 in Southwest (Oyo state) and 140 from North central (Kwara state) catfish farmers through a multi-stage random sampling. Descriptive Statistics and Stochastic Frontier Analysis were employed to analyse the data obtained. Findings shows that majority 69.20% of the farmers were males while 30.8% were females, 75.92% of the farmers practiced rain-fed catfish farming while 24.08% practiced non-rain-fed fish farming. Majority of the farmers have education 88.68% while only 11.42% have no education. Majority of the farmers 59.86% have <5 household members while 32.18% has between 6-10 household members with only 7.96% having members >11 while 32.53% of the sampled farmers fall between 20-40 years while 52.94% fall between 41-60 years of age while 14.53% are above 61 years old. The result of the Stochastic Frontier Analysis indicated that number of fish stocked (Juvenile and fingerlings), pond sizes, labour, feeds and water used are the major determinant of technical efficiency among catfish farmers in Southwest (Oyo-state) and Northwest (Kwara state) Nigeria. The technical inefficiency of the catfish farmers were determined by age, education level, sex, farming experience, access to cooperative associations and household sizes. It is therefore, recommended that the catfish farmers should be support to improve their management practices and enhance their resource use skills by subsidizing fish inputs. Also, human capacity development in aquaculture production through extensive training sessions should be prioritized to enhance their resource use knowledge.

INTRODUCTION

Fish, an important source of protein to the large teaming population, provides 40% of the dietary intake of animal protein to average Nigerian[1]. It accounted for 20% of animal protein derived in low income food, deficient limitless compare with 13% in the industrialized countries[2]. Fisheries occupy a unique position in the agricultural sector of the Nigerian economy. In terms of Gross Domestic Product (GDP), the fisheries sub-sector has recorded the fastest growth rate in agriculture to the GDP. The contribution of the fisheries sub-sector to agriculture GDP was estimated as 4.0% in the year 2007, out of the total estimate of 40% being contributed by agriculture to GDP[1]. On a global scale, almost 16% of total average intake of animal protein was attributed to fish[3]. According to Adekoya and Miller[4], fish and fish products constitute >60% of the total protein intake in adults, especially in rural areas. According to FAO[5], to maintain the present per capita fish consumption level of 13 kg per year, 2.0 million metric tons of fish would be required.

Nigerians are large consumers of fish with demand estimate of 1.4 million metric tons. However, a demand-supply gap of at least 0.7 million metric tons exists nationally with import making up the short fall at a cost of almost 0.5 billion US dollars per year[6]. Domestic fish productions of about 500,000 metric tons (85%) are supplied by artisan fisher-folk despite overfishing in many water bodies across the country[4]. Apart from high availability and relatively cheap cost, there is hardly any religious taboo and any known cultural limitations affecting the consumption of fish unlike pork and beef[7]. Apart from its nutritional importance, fish also add varieties and taste to diets as well as improved palatability of food.

The fisheries subsector serves not only as a source for provision of food but also for employment and foreign exchange for the populace. Fish farming provides important services including supporting nutritional well-being, providing feedstock for the industrial sector, making contributions to rural development, increasing export opportunities, more effective administration of natural resources and conservation of biological diversity[8]. Although, the sector is bed evilled by myriads of problems chiefly is the inadequate supply of quality fish feed, extension support and intensive management strategies as well as lack of cost effective feed and poor infrastructure. Others include limited opportunities for credit or capital access by small-scale farmers and the presence of technical inefficiency which was identified by previous studies focusing on this sector as important for sustainable fish production in Nigeria[9, 10]. There is no gainsaying that protein from animal sources is in short supply in Nigeria due to the rapid increase in human population as well as decrease in livestock population due to several factors including diseases, desertification, drought, water pollution, climate change, global warming, scarcity and high cost of quality feeds, poor genetic qualities and the recent herdsmen crises, etc. These factors have raised the cost of animal protein to a level that is almost beyond the reach of the ordinary citizen and has therefore given rise to a considerable increase in the demand for fish to supplement the needed animal protein intake. Judging from the foregoing, this study investigates the resource use efficiency among rain-fed and non-rain-fed Fish farmers in South West (Oyo State) and North-Central (Kwara State) Nigeria and the constraints facing Cat-fish farming production in the study area.

Empirical and literature reviews: Several authors have analysed the efficiency of resource use in the agricultural sector by using farm level data from many parts of the world. Akenbor and Ike[11] examined the Technical Efficiency (TE) of fish farming in Edo State. The result showed that the TE of the farmers ranged from 0.46-0.99 with a mean of 0.95 at which 77% of them were operating. The study identified high cost of feed, limited capital, poor power supply and high cost of pond construction among others as constraints to fish production in Nigeria.

Alawode and Jinad[12] evaluated the technical efficiency of catfish production using stochastic frontier Production Analysis. Feed inputs and pond size and fingerling are the determinants of technical efficiency among the farmers. Access to credit, education level, culture system, household size and the years of experience in catfish farming were factors that determined technical inefficiency of catfish farms. Also, about 65% of the catfish farmers had technical efficiency scores of 60% or less.

Omobepade *et al*.[13] evaluated the technical efficiency of aquaculturists in Ekiti state, Nigeria. Stock population and pond holdings were the significant factors in the inefficiency model while costs of feed, labour and fingerlings were the significant factors that contributed to the technical efficiency of the aquaculturists. Olasunkanmi and Yusuf[14] used Gross Margin and Stochastic Frontier Analysis to analyse resource used efficiency among Catfish farmers in Osun State. The study find out that increasing the usage of fingerlings and fertilizer would improve the efficiency of these inputs. The major constraints identified are lack of extension officer’s service, insufficient capital, high cost of feed/other input, lack of government assistance, market price fluctuation, preservation/storage/processing problem, flooding during the raining season, land acquisition problem, water problem during the dry season, poaching, menace of predators, high mortality rate and disease and pest infestation in ranking order.

Adebo and Ayelairi[15] found out that farmers in Ondo and Ekiti States witnessed unprecedented change in weather conditions as reflected in unusual excessive rain thus affecting their productivity through flooding.

MATERIALS AND METHODS

Oyo state is one of the six states that make up the South-West geopolitical zone of Nigeria. The landscape consists of old hard rocks and dome shaped hills which rise gently from about 500 m in the southern part and reaching a height of about 1,219 m above sea level in the Northern part. Approximately, it has a land area of 28,454 km^2 with coordinates 8°00 N 4°00 E and 8°00 N 4°00 E (https://Nigeria.open data for Africa.org/apps/atlas /Oyo, 2020). It has an estimated total population of 6,617,720 with a population density of 211 people per square kilometer[16]. The topography of the State is of gentle rolling low land in the South, rising to a plateau of about 40 m. The State is well drained with rivers flowing from the upland in the North-South direction with an equatorial climate of dry and wet seasons and relatively high humidity. The dry season lasts from November to March while the wet season starts from April and ends in October. Average daily temperature ranges between 25°C (77.0°F) and 35°C (95.0°F), almost throughout the year. The vegetation pattern of Oyo state is that of rain forest in the South and Guinea Savannah in the North. Thick forest in the South gives way to grassland interspersed with trees in the north. The climate in the State favours the cultivation of crops like Maize, Yam, Cassava, Millet, Rice, Plantain, Cocoa tree, Palm tree and Cashew.

Kwara state: Kwara state is one of the state in the North-Central geopolitical zone of Nigeria. It has a population of about 2,371,089 with a total landmass of 32,500 km^2 and population density of 89.42 km^2 people per sq. The state lies on 8°30 N 5°00 E of the equator and has bimodal climatic seasons, the dry season and wet season with annual rainfall ranging between 1,000 and 1,500 mm while the average temperature lies between 30 and 35°C. The rainy season lasts between April and October while the dry season starts in November and ends in March of the following year. The land is very fertile and the climate favours the cultivation of arable crops like Maize, Yam, Cassava, Millet, Rice, Plantain, Cocoa tree, Palm tree and Cashew. The climate is also conducive for fish farming. Kwara state has numerous mineral resources such as tourmaline, tantalite and many mineral deposits in the Northern part (https://Nigeria. open data for Africa.org/apps/atlas/Kwara, 2020).

Sampling and data source: The study made use of primary data obtained from active Catfish farmers in Oyo and Kwara states. The data were collected with the aid of well-structured questionnaire with a multi-stage random sampling technique. The first stage was the purposive selection of Oyo from the Southwest region and Kwara from the Northwest region based on Catfish production percentage from the two states. This was then followed by selection of five local governments each from the two states, Egbeda, Ido, Oyo West, Lagelu and Ogbomosho South in Oyo state while Ilorin West, Ilorin East, Irepodun, Ifelodun and Offa were selected in Kwara state respectively. The third stage was the selection of catfish farmers in the towns and villages in the local government selected.

Analytical technique

Stochastic frontier model: The stochastic frontier function is typically specified as:

$$Y_i = f\left(X_{ij} : \beta\right) + V_i - U_i \left(i = 1, 2, n\right) \quad (1)$$

Where:

- Y_i = Output of the ith firm
- X_{ij} = Vector of actual jth inputs used by the ith firm
- β = Vector of production coefficients to be estimated
- V_i = Random variability in the production that cannot be influenced by the firm and
- U_i = Deviation from maximum potential output attributable to technical inefficiency of ith farmer

The above specifications have been expressed in terms of a production function with the interpreted as technical inefficiency effects which cause the firm to operate below the stochastic production frontier. To specify a stochastic frontier cost function, the error term specification is simply altered from (V_i-U_i) to (V_i+U_i). This substitution would transform the production function defined by (1) into the cost function Fasakin and Akinbode[17] and Coelli *et al*.[18]. The stochastic frontier cost function is specified as:

$$LnC_a = f\left(P_a, Y_a : \beta\right) + \left(V_i + U_i\right) \quad (2)$$

Where:

- C_a = Total output in production of the ith firm
- P_a = Input quantities
- Y_a = Output of the ith firm
- β = Parameters to be estimated
- V_i = Systematic component which represents random disturbance cost due to factors outside the scope of the firm
- U_i = One sided disturbance term used to represent cost inefficiency and is independent of V_i

The Cost Efficiency (CE) of an individual firm is defined in terms of the ratio of observed Cost (C_b) to the corresponding minimum Cost (C_{min}) under a given technology:

$$\text{Technical Efficiency}(TE) = \frac{Y_i}{Y_i^*} \quad (3)$$

$$TE = f(X_i, E)\exp\left(V_i - \frac{Ui}{f}\right)(X_i, E)\exp(V_i) \quad (4)$$

$$TE = \exp(-U_i) \quad (5)$$

Where:
Y_i = The observed output
Y_{i*} = The frontier output

Literature reveals that Cobb-Douglass and Translog production functions are the most widely used functional forms in agriculture production functions. However, Translog production form suffers from multicollinearity problem as a result of the square and interaction terms of the input use. The stochastic frontier model in this study is specified as:

$$\text{In}\, Y_i = \beta_0 + \beta_i \text{In} X_y + \beta_2 \text{In} X_2 +, ..., V_{ij} - U_{ij} \quad (6)$$

Where:
C_i = Total fish output (Kg)
T_1 = Number of fish stocked (Numbers)
T_2 = Feeds quantity (Kg)
T_3 = Water used (Kg)
T_4 = Labour amount paid (Naira)
T_5 = Fertilizer (Kg)
T_6 = Pond sizes (m2)

The Vi are random variables which are assumed to be normally distributed N(0,σV2) and independent of the which are non-negative random variables, assumed to be half normally distributed |N(0, Σu 2)| and account for the cost inefficiency in production.

Inefficiency model: The cost inefficiency model is specified as follows:

$$CE_1 = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 + Z_3 + \delta_4 Z_4 + \delta_5 Z_5 \quad (7)$$

Where:
CE = Technical efficiency of the ith Farmer
Z_1 = Age of the farmers (Years)
Z_2 = Sex of the farmers (Male = 1, Female = 0)
Z_3 = Education level (Years)
Z_4 = Access to Extension Service (Yes = 1, 0 otherwise)
Z_5 = Farming Experience (Years)
Z_6 = Household Size (Years)
Z_7 = Membership of Cooperative Association (Yes = 1, 0 otherwise)

The stochastic frontier production and the inefficiency model will be estimated for the two groups (Rain-fed and non-Rain fed fish farmer in the two regions, i.e., South-west and North-Central Nigeria).

Provide information on level of the allocative efficiency of the ith farm. The allocative efficiency of individual farmers is defined in terms of the ratio of the predicted minimum cost (Ci*) to observed Cost (Ci):

$$\text{That is AE} = C_{i*}/C_i = \exp \quad (8)$$

Thus, allocative efficiency is an inverse function of cost efficiency and so, ranges between zero and one[18].

RESULTS AND DISCUSSION

Analysis and presentation of results

Socio-economic characteristics of the fish farmers: Table 1 present the descriptive statistics of the Catfish farmers in the study area. Majority of the farmers 227 (75.92%) use rain water directly for there without any other source while 72(24.08%) used boreholes and wells with rain water, justify the low production of catfish during the dry season and glut experience during the raining season. Findings show that majority 69.20% of the farmers were males while 30.8% were females. Majority of the farmers 62.98% are married, 28.37% are single while 8.65% are separated or divorce. Education distribution shows that majority of the farmers are educated with 11.42% had no education, 25.26% had primary and 29.07% had secondary while 34.26% had tertiary education, respectively. This showed that the farmers in the study area are educated and literate, affirmed the popular believe that catfish farmers are not illiterate as in consonance with Alawode and Jinad[12] finding in their study. Access to extension agents showed that 82.35% of the farmers had contact with the extension agents while 19.03% had no access/contact with the extension agents. The importance of extension service cannot be over-emphasized; they have been veritable tools in bridging between the farmers and the research institutions in disseminating vital agriculture information to the farmers. They have been useful formation of agricultural groups and in linking them with the state ministries in registration process.

The age distribution of the farmers show that 32.53% of the sampled farmers fall between 20-40 years while 52.94% fall between 41-60 years of age while 14.53% are above 61 years old. This indicates that fish production cut across all ages, since is not labour-intensive work as shown from the ages of farmers participating in it. This result was similar to Alawode *et al.*[12] and Adebayo

Table 1: Socio-economic characteristics of the catfish farmers

Variables	South West (Oyo) (N = 149)	North Central (Kwara) (N = 140)	Total (N = 289) (%)
Water source			
Rain-fed	104	123	227(75.92)
Non-rainfed	45	27	72(24.08)
Sex			
Male	105	85	200(69.20)
Female	44	55	089(30.8)
Marital status			
Married	94	88	182(62.98)
Single	45	37	082(28.37)
Separated/Divorced	10	15	025(8.65)
Age			
20-40	52	42	094(32.53)
41-60	68	85	153(52.94)
>61	29	13	042(14.53)
Education level			
No education	16	27	033(11.42)
Primary	28	45	073(25.26)
Secondary	45	39	084(29.07)
Tertiary	60	29	099(34.26)
Household size			
<5	97	76	173(59.86)
6-10	43	50	093(32.18)
>11	09	14	023(7.96)
Extension access			
Yes	128	110	238(82.35)
No	021	030	051(17.65)
Association member			
Yes	131	103	234(80.97)
No	018	037	055(19.03)
Mode of production			
Rainfed	104	113	217(75.09)
Non-rainfed	045	027	072(24.91)
Pond size (m^2)			
0-15	102	091	193(66.78)
16-30	035	033	068(23.53)
>30	012	016	028(9.69)

Author's computation in 2018

and Daramola[19]. The household size distributions shows that majority of the farmers 59.86% have <5 household members while 32.18% has between 6-10 household members with only 7.96% having members >11. The lower percentage of the farmers with higher household size might due to the fact that catfish farming is not labour intensive, hence, each farmers can modestly feed the fish they produced. Majority of the farmers 80.97% are active members of cooperative associations while only 19.03% of the catfish farmers are non-member of any cooperative association. The higher percentage of the Catfish member's participation in cooperative association might due to the benefit gain from it. Fasakin and Popoola[20] emphasised the need for cooperative association as they opined that co-operative associations should integrate adult education as part of their empowerment programmes, so as to boost the literacy level of the rural farmers and increase their chances of getting social and economic inclusion. On the mode of catfish production, majority of the catfish farmers are practising rainfed fish production 75.09% while 24.91% engaged in non-rain catfish farming. The reason for this might due to the cost incur in establishing water system in catfish farming. Details on the mode of production are shown in Fig. 1.

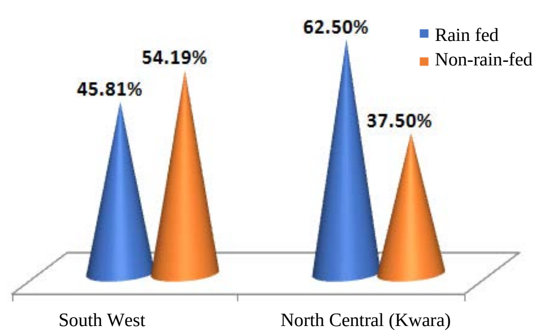

Fig. 1: The distribution of rain-fed and non-rain fed catfish farmers

The distribution of the pond sizes shows that 66.78% of the farmer have their pond sizes between 0-15 m and about 23.53% operated on pond sizes of between 16-30 m and only 9.69% operated above 30 m^2 pond sizes. This shows the low level of production in the farmer's

Table 2: Estimates of the stochastic frontier cost function and the inefficiency model

	South West (Oyo)		North Central (Kwara)	
Region/variable	Rain-fed Coef/SE	Non-rain-fed Coef/SE	Rain-fed Coef/SE	Non-rain-fed Coef/SE
Fish stocked	2.299	0.612***	4.965***	0.363
	(0.217)	(0.241)	(0.005)	(0.161)
Feed	8.144***	-0.385*	4.707***	0.910***
	(0.002)	(0.498)	(0.001)	(0.000)
Water	-1.856	-0.135	2.432	-0.160**
	(0.953)	(0.366)	(0.262)	(0.405)
Labour	1.795	1.060	1.198	0.234*
	(0.201)	(0.171)	(0.667)	(0.093)
Fertilizer	2.426	-0.416	-2.620	-0.122
	(0.602)	(0.168)	(0.013)	(0.580)
Ponds size	-8.598**	0.263	2.280**	0.245**
	(0.013)	(0.367)	(0.025)	(0.240)
Constant	-1.830	0.401	-1.913	-0.316
	(0.333)	(0.263)	(0.000)	(0.000)
Variance parameter				
Sigma squared	0.639	0.433	0.737	0.037
Gamma	0.793	0.636	0.529	0.515
Log likelihood	-825.70468	-45.335364	-669.14094	-40.324397
Inefficiency model				
Age	-0.409	-0.936***	-1.537	7.673
	(3.340)	(6.883)	(0.601)	(1.624)**
Sex	-4.018	0.308	-1.613**	5.250
	(1.265)	(1.420)	(0.222)***	(1.113)
Education	4.311	-0.758	-5.750	0.651**
	(3.540)	(0.296)	(1.765)	(0.481)
Access to extension	-6.424	1.433**	-1.29	1.305
	(1.530)	(0.793)	(0.645)	(0.945)
Farming experience	4.851	-0.658	1.055	-3.031
	(1.421)**	(0.488)**	(1.069)**	(0.182)
Household sizes	1.548	-0.381	2.291	1.712
	(3.295)	(0.477)	(2.655)	(0.912)
Association member	2.080*	-1.585	0.365	0.975***
	(1.644)	(1.323)	(1.081)	(0.346)
Constant	-1.866	1.575	0.802	2.498
	(0.855)	(0.563)	(0.518)	(0.458)
No. of Obs.	104	45	123	27
R-squared	0.764	0.685	0.754	0.690
Log-likelihood	-176.657	-374.9403	-342.632	-238.948
Pseudo R	0.864	0.745	0.827	0.725

Field survey in 2017. *** = 1%, ** =5% and * = 10% Significant level Table 3: Efficiency Scores in South West (Oyo)

capacity. Farmer's that produces extensively will have some big and more capacious ponds that can house about 10,000-20,000 fish for a cycle. This justifies the claims opined by food and agricultural organization FAO and other bodies that fish production in Nigeria is still at the lower ebb.

Determinants of resource use efficiency among the catfish farmers: Results for the estimation of stochastic frontier production for catfish production in the study area are presented in Table 2. The result of the Stochastic Frontiers Analysis was obtained for each region, South-West (Rain-fed and Non-rain-fed) and North Central (Rain-fed and Non-rain-fed). The estimated sigma squared for South west (rain-fed and non-rain-fed) and North central rain-fed and non-rainfed) were 0.64 and 0.33, 0.74 and 0.46, respectively an indication of good fit and the appropriateness of the specified distributional assumption of the composite error. Gamma measures the level of inefficiency in the variance parameter, i.e., the difference between the frontier output and the observed output. The values in South west (rain-fed and non-rainfed) and North central rain-fed and non-rainfed) were 0.73 and 0.64, 0.53 and 0.51, respectively, these values implies that 73, 64, 53 and 51% variation in catfish output was due to inefficiency in input use and other farm practices.

In the Southwest region (Oyo state), among the rain-fed catfish farmers, the estimated coefficient for feed was positive and significant at 1% probability level among the rain-fed farmers in Southwest. The positive sign agrees with the a priori expectation and it implies that as the quantity of feed consumed increases, catfish output increases. This is in agreement with Oyinbo *et al*.[21] and Kareem *et al*.[22] who reported similar result in their findings. The estimated coefficient for pond size

Table 3: Efficiency scores in South west (Oye)

South West efficiency level	Rain-fed Frequency	Rain-fed Percentage	Non-Rain-fed Frequency	Non-Rain-fed Percentage
0.00-0.50	12	11.54	3	06.38
0.51-0.60	8	10.58	7	14.89
0.61-0.70	19	18.27	8	17.02
0.71-0.80	23	22.12	15	31.91
0.80-0.90	14	14.42	10	21.28
0.91-1.00	24	23.08	4	08.51
Mean	0.65		0.71	
Minimum	0.16		0.38	
Maximum	0.92		0.93	

Table 4: Efficiency Scores in North Central (Kwara)

North central efficiency level	Rain-fed Frequency	Rain-fed Percentage	Non-Rain-fed Frequency	Non-Rain-fed Percentage
0.0-0.5	12	9.76	2	7.41
0.51-0.60	19	15.45	8	29.63
0.61-0.70	16	13.01	2	7.41
0.71-0.80	20	16.26	5	18.52
0.80-0.90	34	27.64	3	11.11
0.91-1.0	22	17.89	7	25.93
Mean	0.87		0.69	
Minimum	0.33		0.21	
Maximum	0.95		0.91	

Authors Computation in 2018

was negative and significant at 5% level among the rain-fed in southwest Nigeria. The pond size revealed the economies of scale in catfish farming in the study area. This is in disagreement with Baruwa and Omodara[23] where they had a positive coefficient in pond size. However, the possibility of economic of scale associated with firm size might likely be limited among catfish farmers due to small pond size.

From the non-rain-fed system, the estimated coefficient for fish stocked was positive and significant at 1%, indicating that quantity of fish stocked contribute to efficiency, a unit increase in the amount of catfish fingerlings stocked will yield a corresponding increase in the quantity of catfish output. This is in agreement with the findings by Baruwa and Omodara[23] which had a similar result in their study. The estimated coefficient for feed was negative and significant at 10% probability level among the non-rain-fed farmers in Southwest. The negative sign disagrees with the a priori expectation and it implies that as the quantity of feed consumed increases, catfish output decreases. This is in disagreement with Oyinbo *et al*.[21] and Kareem *et al*.[22] who reported a positive result in their findings.

In the Northwest (Kwara State), the rain-fed catfish farming technical efficiency shows that the estimated coefficient for fish stocked was positive and significant at 1%, indicating that quantity of fish stocked contribute to efficiency, a unit increase in the amount of catfish fingerlings stocked will yield a corresponding increase in the quantity of catfish output. The estimated coefficient for feed was positive and significant at 1% probability level among the rain-fed farmers in Southwest. The positive sign agrees with the a priori expectation and it implies that as the quantity of feed consumed increases, catfish output increases. This is in agreement with Oyinbo *et al*.[21] and Kareem *et al*.[22] who reported similar result in their findings. The estimated coefficient for pond size was positive and significant at 5% level among the rain-fed and non-rain-fed in northwest Nigeria. The pond size revealed the economies of scale in catfish farming in the study area. This is in agreement with (26) Baruwa and Omodara[23] where they had a positive coefficient in pond size. Water used coefficient was positive and significant at 5%. The estimated coefficient of labour used was positive and significant at 10%, this indicates that an increase in labour will lead to an increase in output of catfish harvested. This finding disagrees with Oyinbo *et al*.[21] and Asogwa *et al*.[24] who found that labour had a negative influence on the output.

Technical inefficiency: In the inefficiency model, a positively signed variable indicate reduction in technical efficiency level whilst a negatively signed variable implies increase in technical efficiency level. In rain-fed catfish farming from Southwest (Oyo state), farming experience and membership of cooperative association were statistically significant at 5 and 10%, respectively, while age, education level, access to extension and farming experience was significant at 1 and 5% in the non-rain-fed farming system. In North central (Kwara-State) the rain-fed source of inefficiency are sex at 5%, farming experience 5% while in the non-rain-fed, the coefficient of age, education and membership of cooperative were significant at 5, 10 and 1%, respectively.

Farming experience: The positive sign and significance of farming experience indicates that as catfish farmer's farming experience increases, their inefficiency in catfish production decreases. This is in consonance with a priori expectation for the farmers because over time they would have learnt on the job how to use and combine their resources efficiently. This is in agreement with Okoror etc. where farming experience was also a significant determinant of technical inefficiency.

Association membership Catfish farmers that are members of cooperative association will gain immensely from participation in their activities. Fasakin and Popoola[20] emphasised the need for cooperative association as they opined that co-operative associations among rural farmers in Nigeria where the study affirmed that participation in cooperative association increase their chances of getting social and economic inclusion. Odetola *et al*.[25] found a positive relationship between cooperative association and commercialization of catfish.

Education level: The contribution of education level of the farmers to technical inefficiency negated a priori expectation and the finding that all the fish farmers (100%) were literate, having obtained primary education and above. It could, however, be due to lack of technical education on aquaculture production.

Age of the farmer: As age increases, farmers tend to be less productive. The contribution of age variable to technical inefficiency conformed to a priori expectation that as the fish farmers grew older, their TE would gradually diminish. This finding was in accordance with Ettah and Kuye[26], Akenbor and Ike[11], Abu *et al*.[27] where age had a negative relationship with Technical Efficiency (TE) but negated or contrary to the findings Tsue etc. who found that age was a positive contributor to technical efficiency.

Sex of the farmer: The positive and significance relationship between the estimated coefficients of sex of the catfish farmers implies that resource use efficiency had a decreasing effect on male respondents. The possible reason might be that the female respondents, unlike their male counterparts were less likely to share part of their scarce productive resources with other income generating activities. They tend to operate at full employment of their productive resources and were thus able to achieve higher profit efficiency than their male counterparts. This finding is consistent with Okoror etc.

The technical efficiency scores of the farmers are shown in Table 3 and 4, respectively. The mean, maximum and minimum efficiency scores for the Southwest rain-fed fish farmers were 0.65, 0.16 and 0.93, respectively while for non-rain-fed were 0.71, 0.38 and 0.93, respectively.

In the North central, the rain-fed mean, minimum and maximum efficiency scores were 0.87, 0.69 and 0.33 while in the non-rain-fed have 0.21, 0.95 and 0.91, respectively. These findings shows that efficiency score was highest among rain-fed North central (Kwara state) with maximum efficiency value of 0.95 and lowest among non-rain-fed North central with 0.69.

CONCLUSION

This study was conducted to determine the resource use efficiency among rain-fed and non-rain-fed catfish production in South West (Oyo) and North Central (Kwara) in Nigeria. The results indicated that number of fish stocked (Juvenile and fingerlings), pond sizes, labour, feeds and water used are the major determinant of technical efficiency among catfish farmers in Southwest (Oyo-state) and Northwest (Kwara state) Nigeria. The technical inefficiency of the catfish farmers were determined by age, education level, sex, farming experience, access to cooperative associations and household sizes, all these variables influences technical inefficiency with either positive or negative relationship. The technical efficiency scores findings shows that technical efficiency score was highest among rain-fed North central (Kwara state) with maximum efficiency value of 0.95 and lowest among non-rain-fed North central (Kwara state) with 0.69. The constraint facing catfish productions in the study area are high cost of feeds, access to credit, fish marketing (poor selling price), water availability, fish mortality and theft.

Based on the findings above, the study therefore recommends that catfish farmers should be support to improve their management practices and enhance their productivity by subsidizing fish inputs (juvenile, fingerling, lime, feeds and fertilizer) and making them available at various local governments.

Also, human capacity development in aquaculture production through face-to-face mechanisms which include classroom-based training, seminars, conferences and workshops, emphasizes on the benefit of cooperative associations and its benefits should be put in place in order to increase their expertise on hoe to effectively use their resources.

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