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Technical Efficiency of Aquaculturists in Ekiti State, Nigeria

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Abstract

This study evaluated the technical efficiency of aquaculturists in Ekiti State, Nigeria. Eighty respondents were selected via a multistage sampling technique. The primary data were collected through a well-structured questionnaire administered on the selected respondents. Stochastic Frontier Production Analysis (SFPA) was used to determine the technical efficiency of aquaculturists in the study area. The studies revealed that majority (67.5 percent) of aquaculturists in the study area were in the age bracket of 30 and 59 and had secondary school education (13.81 years of schooling). 67.50 percent of the respondents raised fish in earthen ponds with an average stock population of 2050 fingerlings while 32.50 percent had between 41 and 60 m^2 pond holdings. 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 Aquaculturists. Data analysis from the study further revealed that a typical aquaculturist in the study area had a technical efficiency of 79%.This is a pointer that fish productivity can be increased in the nearest future by about 21% by adopting the technologies and methods practiced by the best farmers in the area. However, the inability of farmers to attain the peak of the production frontier could be attributed to some factors such as inadequate capital, disease outbreak, marketing, poaching and predation. Based on the findings, majority of the respondents were within the economically active age bracket and can be productive if given necessary incentives. Government should therefore provide necessary incentives to boost the morale of aquaculturists in this economic age.

Keywords: Aquaculturist; Elasticity; Socio-economic; Technical efficiency

Introduction

Fish accounts for at least half of the animal protein and mineral intake for 400 million people in the poorest African and South Asian countries, and the role of fish in providing micronutrients and essential fatty acids is even greater [1]. Based on current per-capita consumption targets and population trends, many analysts recognize aquaculture as the only means of satisfying the world's growing demand for aquatic food products [2].

Catches from natural ecosystem has declined over time due to increased anthropogenic activities, overfishing of natural fish stock, environmental pollution and climate change. However, global consumption of finfish and shellfish as food has doubled since 1973. Evidence suggests that the large increase in the aquatic resources production in recent decades has resulted from the enormous growth in seafood demand in the developing countries [3].

Food and Agricultural Organization (FAO) [4] documented that Nigeria supplied about 0.4 percent of global cultured products. This is far from same report which indicated that countries like china supplied 61.6%; India (7.3%), Indonesia (4.3%), Norway (1.8%) and Egypt (1.6%). The country's aim at meeting her fish demand and increasing it global contribution can only be achieved by increasing fish production through aquaculture.

Landau [5], reported that aquaculture is the only means by which more uniform products are produced on a stable basis, thereby increasing the marketability of fish and shellfish. Globally, aquaculture has expanded at an average annual rate of 8.9% since 1970, making it the fastest-growing subsector in food production [4]. Landau [5], stated that aquaculture could directly or indirectly contribute to the livelihoods and nutrition of many hundreds of millions of people, acting as an engine for economic growth and as a diversification strategy in the face of environmental change. Aquaculture can only play a vital role in ensuring future fish availability for food security and nutrition in the country if it's developed and expanded in an economically viable and environmentally sustainable manner.

In Nigeria, aquaculture is still on a developing state characterized by small scale investment, ineffective management and low yield. Fasoranti [6] observed that the development of fish production in the country is faced with the inefficient use of productive resources but can be achieved by simply improving the level of efficiency in resource use. FAO [1] opined that increasing efficiency of resource use and productivity at the farm level is a major pre-requisite for sustainable aquaculture. Measuring technical efficiency at the farm level, identifying important factors associated with the efficient production systems would serve as a panacea to assessing potential for developing sustainable aquaculture.

Fish production in the study area is still in a pedestrian state. The reason why fish production in Ekiti State has not been able to meet fish demand can be attributed to the landlocked nature of the state (enclosed by land with neither sea nor ocean surrounding for fishing purposes) as well as the meager involvement of the populace in aquaculture owing to its huge capital requirements. The Federal Department of Fisheries reported that Ekiti fish demand in Ekiti State stood at 26,825 metric

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tonnes per annum. Out of which about 200 metric tonnes representing 0.75% were produced locally leaving a deficit of 26,625. This deficit is annually supplied by importation thereby negatively affecting the economic growth of the State and Nigerian.

Currently, Ekiti State with a gross domestic product of US$ 2,848 ranked 34th in Nigeria. Hence jobs could be created through aquaculture thereby improving the economic profile of the state.

A number of researches have been conducted on aquaculture study in the study area: overview of status of aquaculture in Ekiti State, Nigeria; impact of fish farming on poverty alleviation in Ekiti State, Nigeria [7]; assessment of impact of extension services on fish farming in Ekiti Sate, Nigeria.

However, no information is available on the determination of technical efficiency of aquaculturists and assessing the influence of some socio-economic factors on production efficiency in the study area. Hence, this study aims at assessing the influence of socio-economic characteristics of aquaculturists on production efficiency as well as estimate the technical efficiency of aquaculturists in the study area.

Research Methodology

The study was conducted in Ekiti State, Nigeria. It is located between Longitudes of 4° 45 to 5° 45 East of the greenish meridian and Latitudes 7° 15-18° 5 North of the Equator. Primary and secondary data were used for this study.

Structured questionnaire were used to assess information on the socio economic characteristics and cost of production of while the secondary data were assessed from the Ekiti State Agricultural Development Programme (EKADP) and Ekiti State Department of Fisheries Services (EKDFS). A multistage sampling technique was used for the selection of the respondents. The first stage was done by purposively selecting eight out of the sixteen Local Government Areas (LGAs). The LGAs were Ado-Ekiti East, Ikere, Ikole, Ise-Orun, Ilejemeje, Irepodun/Ifelodun and Moba. The choice of the LGAs was based on information assessed from the Ekiti State Agricultural Development Programme (EKADP) which revealed that aquaculturists are prominent in the selected LGAs. In the second stage, ten aquaculturists were thereafter randomly selected from each of the LGAs based on the list collected from EKADP. The sample size was eighty respondents interviewed between September and November, 2011.

Methods of data analysis

Determination of socio-economic characteristics of respondents: Descriptive Statistical analysis of means, frequency distribution, percentages and charts were used describe the age, level of education, household size, years of farming experience, pond holdings, stock population and percentage mortality.

Influence of socio-economic characteristics on production: The influence of socio-economic factors on aquaculture production was assessed by the Technical Inefficiency (TI) model outlined by:

$$TI=\delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7 \quad (1)$$

Where:

TI=Technical Inefficiency

Z1=Stock Population

Z2=Mortality (%)

Z3=Pond Holdings (m^2)

Z4=Age (years)

Z5=Education status (number of years of schooling)

Z6=Household size (numbers)

Z7=Years of fish farming experience

δ_0-δ_8 Parameters to be estimated.

Estimation of technical efficiency of aquaculturists

Stochastic frontier production function was used to estimate the technical efficiency of aquaculturists in the study area. It is given as follows:

$$LnY=b_0 + b_1 lnC_F + b_2 lnC_L + b_3 lnC_U + b_4 lnC_G + b_5 lnC_W + b_6 lnC_Z + e \quad (2)$$

Where:

Y =total value of fish output in \$/per annum

C_F= cost of fingerlings stocked in \$/per annum

C_L=cost of labour in \$/per annum

$C_{U=}$cost of fuel in \$/per annum

C_G=costs of feed and feed supplements in \$/per annum

C_W=cost of pond water in \$/per annum

$C_{Z=}$other miscellaneous variable costs in \$/per annum

b_0-b_6=parameters to be estimated

e=error term

The inefficiency model and production function were analyzed at $p<0.05$.

Results and Discussion

Description of socio-economic characteristics influencing production efficiency

Socioeconomic characteristics of aquaculturists by age, level of education, household size, years of farming experience, pond holdings, stock population and mortality rate are presented in Table 1. It revealed that majority (67.5%) of the respondents were within the economically active age (30 to 59 years) with an average of 50.69 years. This finding is in agreement with Lawal [8] who opined that farmers in this age bracket are in their economic age and can be productive if given necessary incentives.

Adeogun [9] recorded 24 to 52 years for fish farmers in Lagos; Banjo (2009) on fish farmers in Ogun State indicated 30 to 49 years; Olawumi [10] indicated that majority of fish farmers in Ogun State fell within the age bracket of 40 to 49 while similar studies by Okwu and Acheneje [11] on fish farmers in Benue State, Nigeria indicated 15 to 60 years. Kehar [12] documented an average of 40 years for freshwater aquaculture fish farmers in the Tripura State of India.

Distribution of aquaculturists by level of education shows that majority (97.5%) of the respondents had one form of western education or the other. Similar studies by Fapounda [13] and Ugwumba [14] indicated that majority of fish farmers in Ondo and Anambra States, Nigeria had secondary education, while Olagunju [15]; Adewuyi [14]; Okunlola [16]; Okwu and Acheneje [11] discovered that fish farmers in Oyo, Ogun Ondo and Benue States, Nigeria had tertiary education

Table 1: Socio-economic characteristics of aquaculturists (n=80).

Variables	Frequency	Percentage	Mean
Age (Years)			
≤ 30	4	5.00	50.69
31-40	9	11.25	
41-50	21	26.25	
51-60	24	30.00	
>60	22	27.50	
Level of Education			
Koranic	1	1.25	
Non formal	1	1.25	
Primary	5	6.25	
Secondary	24	30.00	
Tertiary	49	61.25	
House Hold Size			
≤ 4	18	22.5	6
5-8	47	58.75	
9-12	9	11.25	
>12	6	7.50	
Years of Experience			
≤ 5	46	57.5	5.63
6-10	27	33.75	
11-15	5	6.25	
>15	2	2.50	
Pond Holdings			
≤ 20 m^2	2	2.50	42.59
21-40 m^2	17	21.25	
41-60 m^2	26	32.50	
61-80 m^2	8	10.00	
81-100 m^2	19	23.75	
>100 m^2	8	10.00	
Stock Population			
≤1000	8	10.00	2050
1000-3900	51	63.75	
4000-6900	12	15.00	
7000-9900	2	2.50	
10000-12900	3	3.75	
≥ 13000	4	5.00	
Mortality Rates			
1-5	46	57.50	6.49
6-10	28	35.00	
11-15	3	3.75	
16-20	2	2.50	
>20	1	1.25	

Source: Computed from Field Survey (2011)

respectively. Education is another critical socio-economic factor that affects farmers' innovativeness and hence their productivity, the more educated a farmer is, the more receptive he is likely to be to modern fish farming practices and technologies. The level of education of a farmer is generally postulated to have a positive impact on efficiency of farmers, this is because it facilitates the adoption of new innovation, provides consciousness and awareness which enables decision makers to understand the various decisions to be made on their farms [17].

Majority (58.7%) of aquaculturists in the study area had between 5 and 8 family size. This result is similar to the findings of Okwu and Acheneje [11]; Olawumi [10] who concluded that majority of fish farmers in Benue and Ogun States, Nigeria had a family size between 6 and 10 respectively.

On the years of experience in fish farming, majority (57.5%) of the respondents had below 5 years of experience. The mean years of farming experience of respondents (5.63 years) revealed that fish farmers in the study area are not old in the enterprise. The level of experience determines the level of skill acquisition, i.e., the more the experience they have, and the more they get to know and understand the management practices of fish farming [18]. In a similar study in Benue State, Nigeria, Okwu and Acheneje [11] documented that majority of fish farmers had between 5 and 10 years of farming experience. This assertion agrees with Ekanem [19] who opined that experience matters in adoption of recommended packages of innovations and modern farm technologies.

Descriptive analysis of pond holdings revealed that a typical aquaculturist had a pond area of about 42.59 m^2. This indicates that small holder fish farmers dominate fish farming enterprise in the study area. Larger mean pond holdings of 355 m^2 and 160 m^2 were documented by Adewuyi and Ugwumba [14] for Ogun and Anambra States, Nigeria respectively while a study conducted by Kehar [12] documented 2347 m^2 pond area for fish farmers in the Tripura State of India. However, given the purpose of fish culture, small size of ponds and fragmented holding, it may not be feasible to exploit economies of scale arising from smaller farm sizes.

Furthermore, majority (63.75%) of aquaculturists in the study area had a stock population between 1001 and 3900 fingerlings with a mean stock population of 2050 fingerlings. However, Okunola and Ugwumba [14] discovered that fish farmers in Ondo and Anambra States, Nigeria respectively had a stock population of 5,950 and 2771.65 fingerlings. The low stock population by fish farmers in the study area might be connected to inadequate capital to purchase fish feed. The distribution of aquaculturists by type of fish cultured revealed that majority (88.75%) of the respondents cultured solely catfish.

Catfish culture dominance in the study area might be due to the fact that the African catfish, *Clarias gariepinus* is the most popularly cultured in Nigeria because of its fast growth, disease resistance, hardiness, excellent taste and high market demand [20]. This was however different from aquaculture in Tripura State of India where Rohu (*Labeo rohita*) was the mostly cultured species [12].

Percentage mortality of fish stocked shows that majority (57.5%) of respondeyt's experienced not more than 5 percent stock mortality. From the study, lower stock mortality was observed mostly with respondents who operated in earthen ponds. A mean mortality rate of 6.49% fish stocked is however commendable as this could be linked to the management skills of aquaculturists in the study area.

Variable cost of production

Table 2 presents the variable cost incurred on aquaculture production in the study area. Feed purchases represented 64% of the production cost, labour accounted for 18.71% while fingerlings 14.89% in the study area. Other cost such as cost of vaccines, maintenance of equipment and other miscellaneous cost represents 1.36% of the cost of production. The study indicates that the cost of feed, labour and fingerlings accounted for the larger proportion (91.6%) of the variable cost of production in the study area. This is in line with Olawumi [10] who discovered that cost of labour, fingerlings and feed constituted the lion share in aquaculture cost production in Ogun State, Nigeria. Okwu and Acheneje [11] disclosed that the cost of feed and fingerlings accounted for over 50 percent of expenditure for fish farming in Benue State, Nigeria. However, Ekanem [19] in Cross River State, Nigeria discovered that providing water for aquaculture accounted for 40.59% of the running cost.

Table 2: Variable cost of production in the Study area.

Variable Cost	Mean ($)	Percentage
Water	134.85	4.17
Feed	2072.20	64.00
Fuel	92.98	2.87
Labour	638.23	19.71
Fingerlings	255.32	7.89
Other	44.07	1.36
Total	**3237.63**	**100**

1 USD=162.38 NGN

Source:Computed from Field Survey, 2011.

Table 3: Estimates of efficiency model.

Parameters	Coefficient	T-ratio
Estimates of Inefficiency Model		
Constant (δ_0)	1.43	2.98
Stock Population (δ_1)	0.03*	3.00
Mortality (%) (δ_2)	-0.01	-0.50
Pond Holdings (m^2) (δ_3)	0.03*	3.00
Age (Yrs) (δ_4)	-0.02	-1.00
Level of Education (Yrs) (δ_5)	0.04	0.67
Household size (Number) (δ_6)	0.04	1.33
Years of Farming Experience (δ_7)	0.01	0.33
Estimates of Production Function		
Constant (β_0)	0.13	1.18
Ln Cost of Water (β_1)	0.01	0.33
Ln Cost of Feed (β_2)	0.36*	3.27
Ln Cost of Fuel (β_3)	0.01	0.33
Ln Cost of Labour (β_4)	0.15*	2.14
Ln Cost of Fingerlings (β_5)	0.25*	2.08
Ln Other cost (β_6)	0.18	0.56

Source: Computed from Field Survey, 2011.

*Significant at 5-percent probability level

Influence of socioeconomic characteristics on production efficiency

Table 3 presents the estimates of the stochastic production frontier. It shows that only two of the socio-economic variables (stock population and pond holdings) had significant influence on the total output of fish. The analysis shows that mortality rate, age of respondents, level of education, household size and years of farming experience had no significant effect on aquaculture production in the study area. This is in line with Banjo [21]; Ugwumba [14], and Ekanem [19] who discovered that stock population and pond holdings had significant influence on aquaculture production in Ogun, Anambra, and Cross River States, Nigeria respectively. However, Amos [22] reported that age of respondents and family size had negative and positive effect on crustacean farming in Ondo State, Nigeria respectively.

Cinemre [23] observed that education level, pond tenure and experience had positive effect on cost efficiency of trout farms in the Black Sea Region of Turkey. The author however reported a negative relationship between cost efficiency, feeding intensity, pond size and capital intensity. Dey [24]; Kaliba and Engle [25] revealed that experience had a positive effect on the technical efficiency of tiger fish farming and the production efficiency of catfish farms in Chicot, Arkanas and Mekong Delta of Vietnam respectively. Musa opined that age and level of education affects aquaculture production in Southern Malawi. Similar study by Dey [24] reported that farm size and education had positive effect on technical efficiency in India; in China, it was farm size; Thailand (farm area) while age, education, and farm area were the determinant factors in Vietnam. Education and farming experience were the positive factor that contributed to the technical efficiency of milk fish farming in Taiwan [27]. Kehar [12] indicated that experience and pond area were the significant factors in the technical efficiency of freshwater aquaculture in Tripura, India.

Table 2 further shows that all the variables in the production function had positive coefficients. However, three of the variables (cost of feed, cost of labour and cost of fingerlings) were significant while cost of water, cost of fuel and miscellaneous costs were not significant. Ekanem [19] in Cross Rivers State discovered that cost of water was significant in aquaculture production. Similar studies by Adewuyi; Okwu and Acheneje [11]; and Ekanem [19] discovered that the cost of fingerlings was significant in Ogun, Benue and Cross River and States, Nigeria respectively.

The quantity of fingerlings purchased by a farmer determines the quantity of feed that will be purchased. This discovery is in line with Olagunju [15]; Banjo [21]; and Ekanem [19]. Similar studies by Adewuyi revealed that labour cost was not significant among fish farmers of Ogun State. Olagunju [15]; Ugwumba [14] and Ekanem [19] concluded that feed cost was significant in Oyo, Anambra and Cross River States respectively. Kehar [12] observed that cost of fingerlings and labour had positive effect on production. Singh [27] obtained similar result for the South Tripura district of Tripura State, China. It is good to note in general that parameters such as stock population, pond holdings, feed cost, labour cost and fingerlings cost are very important in the management and sustainability of aquaculture production in the study area.

Technical efficiency of aquaculturists

Table 4 presents the decile range of the technical efficiency estimates. The value ranged between 50 and 85 percent with an average of 79%. This indicates that fish farmers in the study area are efficient. That is, majority of the farmers were operating at their production possibility frontier. Hence, in the nearest future, there is possibility of increasing fish productivity by about 21% by adopting the technologies and methods practiced by the best farmers in the area. Similar study by Kareemin Ogun State, Nigeria discovered that a typical fish farmer had a technical efficiency of 88%. Fapounda [13] documented that fish farmers in Ondo State Nigeria had a technical efficiency of 83%. Amos [22] estimated a technical efficiency of 7% for crustacean farmers in coastal areas of Ondo State, Nigeria.

Similar studies on technical efficiency and its determinants in pond poly-culture in selected Asian countries documented 93% for China; 84% in India; 91% in Indonesia and 40% in Vietnam. Cinemre [23]

Table 4: Deciles Range of Technical Efficiency Estimates.

Efficiency Level	Frequency	Percentage
>0.50	2	2.50
0.51-0.55	1	1.25
0.56-0.60	5	6.25
0.61-0.65	8	10.00
0.66-0.70	8	10.00
0.71-0.75	6	7.50
0.76-0.80	12	15.00
0.81-0.85	8	10.00
>0.85	30	37.50
Total	**80**	**100**

Source: Computed from Field Survey, 2011 reported 82%cost efficiency in trout farms in the Black Sea Region of Turkey; 67% production efficiency reported in catfish farms in Chicot, Arkanas [25]; 63% technical efficiency documented for smallholder fish farmers in Southern Malawi; Dey [24] evaluated 46% technical efficiency for Black Tiger farming in the Mekong Delta of Vietnam; Chiang [26] reported 84% technical efficiency for milkfish farmers in Taiwan while a 42% efficiency was evaluated for carp pond-culture in the Peninsula, Malaysia.

Conclusion

The study has revealed that there is potential for increasing fish production in Ekiti State, Ngeria by increasing the levels stock population and pond holdings and effectively allocating resources feed, labour and fingerlings costs. The technical efficiency has been found to range between 0.50 and 0.85, with mean value of 0.79. This is an indication that productivity can still be increased by 21% by creating awareness about scientific techniques of fish culture and cost-effective technology would play an important role in increasing fish productivity, particularly in fish farms operated by farmers within the economic age. The inability of farmers to attain the peak of the production frontier could be attributed to some factors such as inadequate capital, disease outbreak, marketing, poaching and predation. More emphasis should therefore be placed on resource utilization to further sustain the production of fish in the study area.

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