

# Technical efficiency of pond fish production in Lagos State, Nigeria

## Abstract

Fish farming in Lagos state remains an untapped goldmine. In spite of the great potentials of fish farming in the state, factors such as inability to add value, low technical knowledge on the part of fish farmers and high cost of inputs have constrained the contribution of fish farming to increased food supply in the state. Furthermore, inefficiency of utilization of available resources for pisciculture has remained an unanswered question in the quest for increased production in the state. It is in-lieu of this that this paper set out to analyze the Technical Efficiency of Pond Fish Farmers in Lagos state, Nigeria. The study adopted a survey design. It utilized mainly primary data. A structured close-ended questionnaire was used to collect information from the 120pond fish farmers in the area. Data generated were analyzed using the Stochastic Frontier Analysis (SFA). Average output of fish per production cycle was 14,000kg, while an average farm size (land) was 1.97ha per farmer. Mean scores for pond size ( $=2.22m^2$ ) and feed ( $=3.12N/ha$ ) were also recorded. Six factors namely, farm size, labour, feed, fertilizer, stocking capacity and depreciation value with coefficients of 0.02, 0.28, 0.03, 0.04, 0.40 and 0.20 respectively exerted significant ( $p<0.05$ ) effects on the output of fish. All the production variables analyzed were positive except farm size and feed. The major determinants of efficiency were identified to be farm size and stocking capacity. The farmers are fairly efficient technically, with a mean efficiency estimate of 0.88 ( $=88\%$ ). This study therefore recommended that an aggressive awareness on the importance and training of pond fish farmers on value chain inculcation in their enterprise. Furthermore, provision of market and market information where these fish and fish products could be sold at profitable prices will enhance and ensure that farmers are not only food secured but also financially comfortable.

**Keywords:** efficiency, input, output, fish farming, value chain

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**Abbreviations:** GDP, gross domestic product; CBN, central bank of Nigeria; FMARD, federal ministry of agriculture and rural development; NBS, Nigeria bureau of statistics; AIFP, aquaculture and inland fishery project; NAFFP, national accelerated fish production project; FTP, fishing terminal projects; FIP, fisheries infrastructures provision/improvement; PIA, presidential initiative of aquaculture; CACS, commercial agriculture credit scheme; ACGS, agricultural credit guarantee scheme; NIRSAL, nigerian incentive-based risk sharing system for agricultural lending; ATA, agricultural transformation agenda

## Introduction

In Nigeria, total domestic fish production fluctuated between 562,972 to 524,700 metric tons in 1983 to year 2003; while the output of fish farming during this period was 20,476 to 52,000 metric tons. Fish farming accounted for between 3.64 and 9.92% of total domestic fish production in Nigeria within this period, while the bulk of production came from artisanal fishing. Although the outlook of aquaculture production is worrisome given the growing demand for fish and the declining yield of natural fish stocks due to over-exploitation, fish farming still holds the greatest potentials to rapidly boost domestic animal protein supply in Nigeria. Fish production currently contributes 3.5percent of Nigeria's Gross Domestic Product (GDP) and accounts for 0.2% of the total global fish production<sup>1</sup> as well as provides direct and indirect employment to over 6million people;<sup>2</sup> but if optimally explored has the potential as an enterprise

to contribute significantly to the possible creation of 30,000 jobs and generation of revenue of US\$160million per annum, which would invariably improve the agricultural sector and boost the Nation's economy at large.<sup>3</sup> Fish farming is an integral component of the overall agricultural production system in Lagos State, Nigeria. The terrain of most part of the State is swampy and prone to seasonal flooding. This makes a vast expanse of land in these areas unsuitable for crop farming. The prevailing hydrographic conditions therefore make fish farming a very attractive alternative production to which the abundant land and water resources in Lagos State can be put.<sup>4</sup>

An efficient method of production is that which utilizes the least quantity of resources in order to produce a given quantity of output. A production process that uses more physical resources than an alternative method in producing a unit of output is thus said to be technically inefficient. However, since economic efficiency embodies both technical and allocative efficiencies, once the issues of technical inefficiency have been removed the question of choosing between the set of technically efficient alternative methods of production, allocative efficiency, comes to fore. According to Oh et al.,<sup>5</sup> allocative efficiency is the ratio between total costs of producing a unit of output using actual factor proportions in a technically efficient manner, and total costs of producing a unit of output using optimal factor proportions in a technically efficient manner. However, a farm using a technically efficient input combination may not be producing optimally depending on the prevailing factor prices. Thus, the allocatively efficient level of production is where the farm operates at the least-cost combination

of inputs. According to Yotopoulos et al.,<sup>6</sup> a firm is allocatively efficient if it was able to equate the value of marginal product (MVP) of each resource employed to the unit cost of that resource; in other words, if it maximizes profit. Therefore allocative efficiency measure, quantifies how near an enterprise is to using the optimal combination of production inputs when the goal is maximum profit.<sup>7</sup>

In addition to the facts above, Nigeria is proudly the most resourceful and vibrant African nation in the aquaculture industry and currently the leading producer of catfish in Africa.<sup>3</sup> "It is sad to note that we are still far behind in our efforts at reaching optimality (i.e. tapping the highest potentials from every resource use and production pattern) in fish farming thereby often leading to artificial glut, low value of non-exportable aquaculture products".<sup>8</sup> Due to these facts, value chain has gained more recognition and importance as a way of fighting poverty and achieving food security for fish farmers, this was in-line with the statement of Gradl et al.,<sup>9</sup> who opined that involving smallholder farmers in commercial value chains can boost their incomes and improve their food security.

### Problem statement

Fish farming in Lagos state and Nigeria at large till date remains an untapped goldmine based on the fact that Nigeria is a maritime nation, it is also blessed with a vast population of over 160million people and a coastline measuring approximately 853kilometres. According to Tobor,<sup>10</sup> there are about 1.75million hectares of suitable land for aquaculture in Nigeria and 25% of this will yield 656,820tonnes of fish per year when placed under cultivation. Similarly, about 6,450tonnes of fish can be produced annually from 75,000 hectares of coastal lagoons.<sup>11</sup> In spite of the great potentials of fish farming in the study area, factors such as low technical knowledge on the part of fish farmers and the high cost of production inputs have constrained its contribution to increased food supply and poverty reduction. Furthermore, the efficiency or inefficiency of utilization of available resources for fish farming has remained an unanswered question in the quest for increased Pisciculture production in Lagos State in particular, and Nigeria at large.

According to FAO,<sup>12-14</sup> around 50% of fish demanded is currently being met by local supply in Nigeria. Adekoya et al.<sup>15</sup> backed this up by stating that domestic fish production of about 500,000metric tons is supplied by 85% of artisan fish-folk. According to Nigeria Bureau of Statistics<sup>16</sup> it was estimated that annual fish demand in the country was about 2.66million as against the annual domestic production of about 0.78million, giving a demand-supply gap of about 1.8million metric tons. Regrettably, the supply of food fish has been on the decline and this is due to consistent declines from the country's major source of food fish.<sup>17</sup> This shortfall is said to be abridged by the importation of 680,000metric tons annually consuming about N50billion in foreign exchange,<sup>18</sup> therefore ranking Nigeria as the highest importer of frozen fish in the world with an annual foreign exchange drain of N50billion.<sup>19,20</sup> The imminent challenge therefore, is to increase the potentials of pisciculture as well as bridging the wide gap between fish demand and supply in Nigeria.

The interest on pisciculture has increased over the years rapidly as a result of the awareness of the importance of this practice to individuals and the economy at large, as well as the advantages attached to it. Oladeji et al.,<sup>21</sup> further observed that various attempts by the government to improve fish supply in the country by importation failed, therefore prompting the Government of Nigeria to initiate

various programs such as: Presidential Initiative on Fisheries and Aquaculture Development 2003; Aquaculture and Inland Fishery Project (AIFP); National Accelerated Fish Production Project (NAFPP); Fishing Terminal Projects (FTP); Fisheries Infrastructures Provision/Improvement (FIP); Presidential Initiative of Aquaculture (PIA); Commercial Agriculture Credit Scheme (CACCS); Agricultural Credit Guarantee Scheme (ACGS); Nigerian Incentive-Based Risk Sharing System for Agricultural Lending (NIRSAL) Programme Initiated by the Central Bank of Nigeria FMARD<sup>22</sup> and currently, Agricultural Transformation Agenda (ATA). Furthermore several government parastatals in Nigeria planned to collaborate to establish industries for expanding production, canning and further processing of fish produce, particularly tilapia and cat fish which can easily multiply in large numbers and grow rapidly. Despite all these interests shown so far by the government and the private sectors in the production of fish generally, the gap between the demand for fish and domestic supply in Nigeria have ever been widening.<sup>3,23</sup>

Worthy of note is the fact that local supplies in terms of inputs do not match the required outputs. That is, fish production cannot be single-handedly increased without the increment in other factors needed for the proper production and development of fishes such as feeds, fertilizers (organic and inorganic), drugs and other implements. According to Adikwu et al.,<sup>23</sup> of all inputs required in rearing fish, feed costs more than 40% of capital investment, while labour follows suit with about 15%. This is evident as the NBS record showed that Nigeria spends N117.7billion annually on the importation of fish feeds over the last decade.<sup>24</sup> Though the Federal Government however had disclosed recently that Nigeria is saving N300million annually from the substitution of imported fish feeds, with an estimate of 25percent of the 45,000metric tones imported into the country<sup>24</sup> this is still a far cry from what we should be aspiring for.

**Objective:** The objective of this work is to analyze the effects of socioeconomic characteristics on the technical efficiency of pond fish farmers in Lagos State, Nigeria.

**Significance of Study:** The findings of the study will be useful for potential and practicing fish farmers, policy makers, researchers, extension agents and the general public at large. It will aid potential fish farmers in their enterprise selection, resource use efficiency and production pattern decisions.

### Research methodology

**Study area:** The study was carried out in Lagos state, Southwestern region of Nigeria. This state was chosen because of the abundance of pisciculture enterprises and endowment of the region with water bodies which facilitated the operational existence of fish farms as the major agricultural activity in this region. It is also very familiar to the researcher as it increased the ease of data collection. Lagos State was created on May 27, 1967 by virtue of State (Creation and Transitional Provisions) Decree No. 14 of 1967, which restructured Nigeria's Federation into 12 states.<sup>25</sup> Lagos State is an administrative division of Nigeria, located in the Southwestern part of the country; with a land mass spanning over 3345sqkm/1292 sq m, lies between Latitudes 6°35'N of Equator and Longitude 3°45'E of Greenwich Meridian<sup>26</sup> possesses a population of 180million people.<sup>27</sup>

Lagos state is located on four principal islands and adjacent parts of the Nigerian mainland. The islands are connected to each other and to the mainland by bridges and landfills.<sup>28</sup> Equally, the metropolitan areas (Colony Province) of Ikeja, Agege, Mushin, Ikorodu, Epe and

Badagry were administered by the Western Region.<sup>29</sup> The climatic weather condition of this region has made it favourable for fish farming to take place. It has also allowed for survival and multiplications of various fish species found in this environment.<sup>28</sup> Geographically, the state is located on the Bight of Benin (an arm of the Atlantic Ocean),<sup>28</sup> which makes the people of Lagos state to engage mostly in fishing enterprises. It is a semi-tropical rainforest vegetation, and has a humid climate with a temperature of about 27°C.<sup>25</sup>

Though, considered as the smallest in terms of area amongst Nigeria's states, Lagos State is arguably the most economically

important state of the country, as well as it is the nation's largest urban area<sup>26</sup> and most populated urban area in the whole of Africa.<sup>30</sup> To date, it remains the center of commerce for the country. Lagos State is divided into five Administrative Divisions, which is then further divided into 20 Local Government Areas.<sup>30</sup> The first 16 of the LGAs are the Metropolitan Lagos while the remaining four LGAs are within Lagos State but are not part of the Metropolitan Lagos. In 2003, many of the existing 20 LGAs were split for administrative purposes into Local Council Development Areas (LCDAs) (Table 1). These lower-tier administrative units now number 56.

**Table 1** Administrative divisions and local government areas of Lagos State

LGA name	Area (km <sup>2</sup> )	Census 2006 population	Administrative capital
Agege	11	459,939	Agege
Alimosho	185	1,277,714	Ikotun
Ifako-Ijaye	27	427,878	Ifako
Ikeja	46	313,196	Ikeja
Kosofe	81	665,393	Kosofe
Mushin	17	633,009	Mushin
Oshodi-Isolo	45	621,509	Oshodi/Isolo
Shomolu	12	402,673	Shomolu
<b>Ikeja Division</b>	<b>424</b>	<b>4,801,311</b>	
Apapa	27	217,362	Apapa
Eti-Osa	192	287,785	Ikoyi
Lagos Island	9	209,437	Lagos Island
Lagos Mainland	19	317,720	Lagos Mainland
Surulere	23	503,975	Surulere
<b>Lagos Division</b>	<b>270</b>	<b>1,542,279</b>	
Ajeromi-Ifelodun	12	684,105	Ajeromi/Ifelodun
Amuwo-Odofin	135	318,166	Festac Town
Ojo	158	598,071	Ojo
Badagry	441	241,093	Badagry
<b>Badagry Division</b>	<b>746</b>	<b>1,841,435</b>	
Ikorodu	394	535,619	Ikorodu
Ikorodu Division	394	535,619	
Ibeju-Lekki	455	117,481	Akodo
Epe	1,185	181,409	Epe
<b>Epe Division</b>	<b>1,640</b>	<b>298,890</b>	

Source: Lagos State official website.<sup>25</sup>

### Sample techniques

A multi-stage sampling technique was adopted for this study. Firstly, four (4) Administrative Divisions out of the five (5) in the state were purposively selected; and these include Ikeja, Lagos, Badagry and Epe division. This was due to the predominance of fish farmers in these zones. The second stage involved the purposive selection of two (2) Local Government Areas each from the above selected four (4) Administrative Divisions of the state, they are as follows: Alimosho,

Kosofe, Eti-Osa, Lagos Island, Ojo, Amuwo-Odofin, Epe and Ibeju-Lekki Local Government Area. This is also mainly due to the predominance of fish farmers in these areas. The third stage involved random selection of three (3) communities from each of the eight (8) LGAs selected above. Lastly, the fourth stage randomly sampled five (5) fish farmers from each of the twenty-four (24) communities selected above. This gave a total of 120 respondents to be sampled. The researcher administered the questionnaires though sought the help of extension workers whenever required.

### Model specifications

Cobb-Douglas Functional form of the Stochastic Frontier Analysis: The Cobb-Douglas functional form of the stochastic frontier was used to determine the technical efficiency of fish farmers in study area. This enabled us to measure the technical efficiency and the relationship between factor-product in pisciculture value chain in this area. A Cobb-Douglas. Therefore, the stochastic frontier model to be adopted was the one used by Battese et al.<sup>31</sup> In the model, it was assumed that the farm frontier production function can be written as:

$$Y = \beta_0 \prod_{i=1}^6 X_i^{\beta_i} + U_i \quad (1)$$

Where

Y is the quantity of fish output, Xi is a vector of input quantities, and β is a vector parameter, Vi= random error term and Ui= non-negative one sided error term that measures inefficiency. The empirical model of the stochastic production function frontier applied in the analysis of efficiency of the production system of pisciculture farmers is specified as:

$$\ln Y_{ij} = \ln b_0 + b_1 \ln X_{1ij} + b_2 \ln X_{2ij} + b_3 \ln X_{3ij} + b_4 \ln X_{4ij} + b_5 \ln X_{5ij} + b_6 \ln X_{6ij} + U_{ij} \quad (2)$$

Where: Y=total output (Kg)

X<sub>1</sub>=farm size measured in Hectares (Ha)

X<sub>2</sub>=labour used in fish production (man/days)

X<sub>3</sub>=feed measured in Naira (N)

X<sub>4</sub>=fertilizer in Naira (N)

X<sub>5</sub>=Stocking capacity (no of fingerlings)

X<sub>6</sub>=depreciation value of fixed inputs in naira (N)

ln=Natural logarithm

## Results and discussions

### Factor-Product Relationship in value chain pisciculture

The summary statistics of the variables used for the stochastic frontier production function is shown in the Table 2 above. Average output per farmer per production cycle is 14,000kg while the analysis of inputs revealed an average farm size of 1.97ha per farmer, an indication that the study covered small-scale family-managed farm units. The average labour used of 748.33 man-days per hectare per cycle shows that fish farmers still depend heavily on human labour to do most of the farm operations. With relatively available cheap labour in Nigeria, extensive use of human labour for farming has been shown to make fish farming, especially in the urban areas, profitable.<sup>32</sup> The summary further revealed that fish farmers were experienced (11.7years) and educated with about 14.4years of schooling. Both experience and education could equip the farmers with relevant skills for enhanced farm management and hence productivity. The farmers were young as indicated by a mean age of 42.5 years. The maximum likelihood (ML) estimates of the parameters of the stochastic production frontier were obtained using the sigma squared (0.0058), which is statistically significant and different from zero at α=0.01.

This indicates a good fit and the correctness of the distributional form assumed for the composite error term. The variance ratio, known as gamma (γ)=9.99, indicates that systematic influences that are unexplained by the production function are the dominant sources of random error. This means that 85.7% of the variation in output among the fish farmers was due to disparities in technical efficiency. The presence of one sided error components in the specified model is thus confirmed, implying that ordinary least square estimations would have provided an inadequate representation of the data. The generalized likelihood ratio test (λ<sup>2</sup>=0.6342) is significant. The result of the judgment statistics does confirm that the stochastic frontier model appears to be a significant improvement over an average (OLS) production function.

The estimated ML coefficients of all the variables in the production function were all positive and conformed with the a priori expectation, indicating that the estimated production function is an increasing function. The coefficient of land size was positive and significant with a production elasticity value of 0.158. Therefore, a 10% increment in land size will increase output of fish by 1.58%. This means that there is scope for increasing output by expanding farmland. The coefficient of labour was positive and significant at a 5% level of probability, showing the importance of labour in fish production in the area. This might be because all agronomic practices involved in fish production are done manually, thus confirming the labour intensity of the livestock farming. Several other studies<sup>33-36</sup> also had similar findings.

The production elasticity value of output with respect to quantity of fertilizer applied was 0.4296. The coefficient was statistically significant at 5% probability level. This means that if the quantity of fertilizer was increased by 10%, output will be improved by a margin of 4.296%. The aquatic nature of fish should make its output heavily dependent on water fertility, and under commercialized fish farming, water fertility maintenance is very crucial for sustenance. The coefficient of organic fertilizer was positive and significant at a 1% level of probability. The production elasticity of manure (0.4543) shows that if the quantity of manure was increased by 10%, output will be increased by 4.5%. The farmers usually augment their inorganic fertilizer application with that of poultry manure, which is usually cheaper and environmentally friendlier.

From Table 3 above, the sigma squared (0.225) is statistically significant and different from zero at α=0.01. This indicates a good fit and the correctness of the distributional form assumed for the composite error term. The variance ratio, known as gamma (γ)=9.99, indicates that systematic influences that are unexplained by the production function are the dominant sources of random error. This means that 99.9% of the variation in output among the fish farmers was due to disparities in technical efficiency. The presence of one sided error components in the specified model is thus confirmed, implying that ordinary least square estimations would have provided an inadequate representation of the data. The generalized likelihood ratio test (λ<sup>2</sup>=0.4765) is significant. The result of the judgment statistics does confirm that the stochastic frontier model appears to be a significant improvement over an average (OLS) production function.

The estimated ML coefficients of all the variables in the production function were all positive except pond size and feed cost which conformed to the a priori expectation, indicating that the estimated production function is an increasing function. The coefficient of stocking capacity was positive and significant with a production

elasticity value of 0.3990. Therefore, a 10% increment in stocking capacity will increase output of fish by 3.99%. This means that there is scope for increasing output by expanding farmland. The coefficient of labour was positive and significant at a 5% level of probability, showing the importance of labour in fish production in the area. This might be because all agronomic practices involved in fish production are done manually with hand tools, thus confirming the labour intensity of livestock. Several other studies<sup>33-36</sup> also had similar findings.

The production elasticity value of output with respect to quantity of fertilizer applied was 0.4296. The coefficient was statistically significant at 5% probability level. This means that if the quantity of fertilizer was increased by 10%, output will be improved by a margin of 4.296%. The development nature of fish should make its output heavily dependent on fertility of water, and under intensive system of fish farming, water fertility and maintenance is very crucial for sustenance. The coefficient of depreciation of fixed asset used was positive and significant at a 5% level of probability. The production elasticity of depreciation of fixed asset (0.1947) shows that if the fixed asset is increased by 10%, output will be increased by 1.95%. This could translate to a higher density of fish produced per pond and perhaps a higher output. This finding is similar to those of.<sup>34-37</sup>

In the efficiency model as shown in the table 3 above, educational level, household size, and farming experience were all positive but

not statistically significant. The age of the farmer had a negative coefficient but was also not significant. Pond size was, however, negative and significant in the efficiency model.<sup>38</sup> This suggests that smaller ponds are more efficient than larger ponds. Considering the small scale nature of fish farming in the area, this result further supports Schultz's<sup>39</sup> hypothesis that small farm households in developing countries are "poor but efficient". Also, Mkhabela,<sup>40</sup> in comparing the efficiency level between small and large scale farmers, noted that small scale farmers (those who have below 1ha of vegetable farm) were more efficient than large scale farmers (those who have above 1ha of vegetable farm).

Table 4 above shows the Frequency of distribution of technical efficiency of fish farmers. There is a variation in the level of efficiency among the farmers, ranging from 0.50- 0.99% with a mean efficiency level of 0.88. However, 93.4% of the farmers had a technical efficiency of 70% and above. This implies that, on the average, farmers are able to obtain 88% of potential output from a given mix of production inputs. In the short run, there is scope for increasing fish output by 12% through the adoption of the techniques and technology employed by the best fish farmers. The implications of the results is that an average farmer could realize a 5.78% cost saving {i.e. 1-(88.0/93.4)\*100} to achieve the technical efficiency level of its most efficient counterpart. A similar calculation on the most technically inefficient farmer reveal cost savings of 39.08% {i.e.1-(56.9/93.4)\*100}.

**Table 2** Summary statistics of output and explanatory variables

Description	Unit	Mean value	Std. Deviation	Max. Value	Min. Value
Output	Kg	14,000	4,792.08	20,000.00	6,000.00
Labour	Man-days	748.33	31,264.32	1200	500
Land	Hectares	1.97	1.15	6	0.5
Fertilizers	Naira	4,916.67	2,875.81	15,000.00	1,250.00
Feed	Naira	1,618,666.67	1,024,830.33	5,000,000.00	400,000.00
Household size	Number	5.12	1.9	9	2
Farming Experience	Years	11.7	4.18	20	6
Education	Years	14.4	3.12	20	6
Age	Years	42.5	7.21	59	30
Depreciation cost	Naira	59,000	34,509.77	180,000.00	15,000.00

Source: Field survey (2014).

**Table 3** Maximum likelihood estimation of the Cobb-stochastic production function

Production Factors	Parameters	Coefficient	Standard error	T-value
Constant term	$\beta_0$	3.2121	0.3094	0.1038
Pond size	$\beta_1$	-0.0222	-0.5144	-0.4308
Labour	$\beta_2$	0.2756	0.1019	2.7049**
Feed	$\beta_3$	-0.0031	0.026	-0.1197
Fertilizer	$\beta_4$	0.043	0.0097	4.4424***
Stocking capacity	$\beta_5$	0.399	0.0987	4.0419***
Depreciation value	$\beta_6$	0.1947	0.0864	2.2522**
<b>Efficiency factors</b>				
Constant term	$d_0$	-0.3489	0.9763	-0.3573
Years of schooling	$d_1$	-0.0527	0.0778	-0.6774
Age of fish pond	$d_2$	-0.1685	0.1464	-1.151
Age of farmer	$d_3$	-0.1475	0.2898	-0.509
Farming experience	$d_4$	0.018	0.0612	0.2898
Household size	$d_5$	0.3018	0.2142	1.4084
Membership cooperative	$d_6$	0.1217	0.0582	2.0928**
Credit access	$d_7$	-0.0246	0.0528	-0.4655
Sex	$d_8$	-0.0246	0.0528	-0.4655**
Extension contacts	$d_9$	0.1923	0.136	1.4142
<b>Variance parameters</b>				
Sigma squared	$\sigma^2 = \sigma^2_v + \sigma^2_v$	0.2253		
Gamma	$\gamma = \sigma^2_v / \sigma^2$	9.9999		
Log likelihood function		63.4199		
LR test		34.1319		
No. of observations	120			

Source: Computer Printout of FRONTIER 4.1c, using field survey data, 2013/14  
 Note: \*\*\*=significant at 1%, \*\*=significant at 5% level of probability.

**Table 4** Frequency distribution of technical efficiency of fish farmers

Efficiency level	Frequency	Percentage
0.50 - 0.59	1	1.2
0.60 - 0.69	7	8.4
0.70 - 0.79	8	9.6
0.80 - 0.89	33	39.6
0.90 - 0.99	69	44.2
Total	120	100
Maximum value=0.97		
Minimum value=0.57		
Mean efficiency=0.88		

Source: Field survey (2014).

## Recommendation

Based on the results of this study, the following recommendations are given

### The pond fish farmers should

- i. Embark on practices like formation of cooperatives that would enhance procurement of credit facilities and attraction of both government and Non-governmental agencies which would bring along essential inputs required for value chain pisciculture.
- ii. Improve their farm productivity by embarking on practices that would enhance procurement of inorganic fertilizers for their production. This could include forming cooperative societies which would assist to pool the resources of the members for bulk purchase of inorganic fertilizers, feed and other resources required for efficient production.
- iii. The fish farmers should carefully consider an economic reduction in fertilizer utility in the study area, thereby reducing the cost of production and raising the profit margin of their respective farms.

### The Government should

Structure and Institutionalize Business Information Outreach and Technical Support for pond fish farmers. This could be achieved by:

- i. Encouraging Business and Technical Information Services through Developing a Pisciculture Business Training Module for use by Fingerling Producers as an embedded service which could go alongside credit/incentive procurement for pond fish farmers.
- ii. Developing easy to use training materials and help train fingerling producers recognized by ADP to be certified pisciculture business trainers.
- iii. Supporting the on-going dissemination of business and technical training material to a wider network of pisciculture producers through these fingerling producers, by assisting in setting up and providing feedback for the initial training sessions.

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## Conflict of interest

The author declares no conflict of interest.

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