Technical efficiency OF Catfish Production among small holder Farmers in Anambra State of Nigeria

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Abstract.

This study was carried out to investigate resource use efficiency of catfish production in Anambra State of Nigeria. A multi stage random sampling technique was used to select 120 catfish farmers in the State in the year 2015. Percentage response was used to determine the farmers' socioeconomic characteristics and the constraints to catfish production. Maximum likelihood methods was used to address stochastic frontier and simultaneously the determinants. The results of the study show that level of education, farming experience and extension contact were positive and significantly related to technical efficiency while credit access had inverse relationship with technical efficiency. The mean technical efficiency was 0.44; the maximum efficiency was 0.97, while the minimum was 0.23. The constraints to catfish production in the study area were poor access to credit, poor fish breed, water pollution, problem of climate change and poor access to extension services. Policies aimed at encouraging both new entrant and older farmers into catfish farming through provision of improved production inputs, increasing farmers' access to extension contact and educational programmes such as adult education, workshop and conferences were therefore recommended.

Keywords: *Technical efficiency, Catfish Production, Small holder, Farmers*

Introduction.

The import of food security to the socio, political and economic developments of any nation whether developed or developing is well acknowledged (Chikaire, et al 2010 and Ume, et al 2010). Food security according to Food Agricultural Organisation (FAO)(2007) is the ability of any nation to ensure that at all times, its people has both physical and economic access to food to sustain household energy, health and to meet nutritional requirements. Nevertheless, nowadays, food insecurity has become a global problem with sub Saharan Africans and South East Asian being more vulnerable to the peril. The threats to food insecurity could manifest in form of low capability to perform work, poor attitude towards work, concomitant high food prices; protests, food riots and long food queues in many countries of the world (Iwundu, 2009) To assuage this phenomenon, most governments especially in the developing countries have embarked in aggressive agriculture revolution as other avenues of alleviating the bane such as food importation and food aid are counterproductive in any nation,s development (FAO, 2006).

In Nigeria, fish farming is gaining prominence and this development could be related to limited supply of fish from marine and fresh water capture fisheries to meet the growing demand for animal protein for man consumption (Adiukwu, 2000). The per animal consumption in Nigeria according to studies stand at 28. 0 kg/ annum, of these 10.6 kg or 37% is derived from fish (Ejindu, 2003; Ranal, 2007). The demand for fish in Nigeria stands at 1.5million metric tons, the domestic production stands at 550,000 metric tons, while the import stands at 700, 0000 metric tons at the cost of US $ 5000 million annually (Ejike and Adedeiji, 2010). These importations of these magnitudes are serious threat to the nation declining natural reserve, hence the need to turn to the underutilized water ways for development of aquaculture.

Aquaculture as asserted by FAO (2006) accounts for close to 50% of the present global fish consumption. Furthermore, globally, aquaculture business as reported by F AO (2007) is a lucrative one as it runs into billions of dollars annually with African alone netting an estimated 2.7 billion dollars per year in exporting fishery products and services. The other imports of aquaculture are source of employment, livestock feed and industrial raw material ((Nwosu *et al.* 2003).

In Nigeria, aquaculture production was estimated at 15,000 metric tons per annum and ranked second in Africa after Egypt (Adikwu, 2000). The production figure could be largely related to the natural endowment including virtually uninterrupted year round environment that support uninterrupted growth of fish and other organisms (Amaefula, *et al.*, 2010). Anambra State is endeared to aquaculture business as the state is bordered by rivers, streams and swamps (Obubuenyi, 2005), abundant rainfall, effective harvest and storage of surface water run off (Ike, 2003). In the state, catfish production is popular among small scale fish farmers and amongst the catfish reared are Heterobranchus longifilis, Heterobranchus bidarsalis, Clarias gariepinus and Heterotis niloticus (Nwosu, et al 2003, Ranal, 2007). The commonest fish pond enclosures used are earthen pond, concrete pond, tarpaulin, fibre glass tank, and plastic tanks (Obubuenyi et al 2005).

Catfish has intrinsic features such as being hardy, tolerate dense stocking, and thrive in a wide range of environmental conditions(Ranal; 2007). Furthermore, catfish is easily spawned under proper conditions, yet will not spawn when placed in the grow-out ponds, which gives the farmer control over the production process (Ike, et al 2003). Fish contains n -3 (DHA; EPA) AND n – 6(AA) unsaturated fatty acid. It is also rich in amino acid, vitamin (A, D and E,),and minerals(iodine and selenium)(FAO,2006). The constitution of fish with highly unsaturated fatty acids of n – 3 and n – 6 series is the major antidote for people with high cholesterol levels (Fazande, et al 1991). As result of the greater awareness of the importance of fatty acids in human diets, there is now general growth of fish consumption in most societies, whether developed or developing countries. For instance, studies show that fish is a source of protein and vitamins for 300 – 500 million people from the poorest Africa and South Asian countries, who depend on food of low nutritional value (World Bank, 2004). Importantly, fish when compared with livestock, it requires less space, time and has high feed conversion ratio , hence it is among the best options to combat protein deficiency in the menu of people in the rural areas of sub Saharan Africa (FAO 2006).

Despite the significances of fish production, in Nigeria and many other developing countries, fish production in general is impeded by low productivity, high mortality, water problems, high cost of feed and poor management practices (Nwosu *et al.* 2003; Amaefula *et al.*, 2010). Moreso, FAO (2006) reported other limitations to include inaccessibility to finance and credit facilities by the farmers, high cost of improved fish seeds, and high cost of capital. Nwaru *et al.* (2010) reported on the concern of government persistent and awfully low budgetary allocation to agriculture for the past few years, as the budgetary allocation to agriculture has not exceeded 10 percent. This immensely contributes in no small measure to low level of output per unit of aquaculture farm per farmer in general, resulting in low income accruing to the farmer.

These myriads of problems decline the domestic production of the catfish, thus limiting its traditional role in economic development. However, to achieve high productivity in catfish production requires that resources should be used more efficiently with more attention paid on attainment of production goal without waste (Nwaru, et al 2010). Efficiency is an important factor in productivity growth, especially in an economy where resources are scarce and opportunities for new technologies are lacking. Specifically, the objectives of the study are to estimate the technical efficiency of the farmers and identify the determinant factors.

Theoretical Framework

The term efficiency of a firm can be defined as its ability to produce the largest possible quantity of output from a given set of inputs. The modern theory of efficiency dates back to the pioneering work of Farrell (1957) who proposed that the efficiency of a firm has two components namely: technical and allocative efficiency and the combination of these two components provide a measure of total economic efficiency (overall efficiency). Technical efficiency which is ability to produce a given level of output with a minimum quantity of inputs can be measured either as input conserving oriented technical efficiency or output-expanding oriented technical efficiency (Jondrow *et al*, 1982).

Measurement of farm efficiency via frontier approach has been widely utilized and studied. The term frontier involves the concept of maximality in which the function sets a limit to the range of possible observations (Forsund *et al*, 1980). The observation of points below the production frontier for firms producing below the maximum possible output can occur, but there cannot be any point above the production frontier given the available technology. Deviations from the frontier are attributed to inefficiency. Frontier studies are however classified according to the method of estimation. Kalaizandonakes *et al* (1992) grouped these methods into two broad categories – parametric and nonparametric methods. The parametric method can be deterministic, programming and stochastic depending on the specification of the frontier model. Many researchers including Schmidt (1976) have argued that efficiency measures from deterministic models are affected by statistical noise.

This however led to the alternative methodology involving the use of the stochastic production frontier models. The major feature of the stochastic production frontier is that the disturbance term is a composite error consisting of two components; one symmetric, the other one-side component. The symmetric component, Vi, captures the random effects due to measurement error, statistical noise and other influences, and is assumed to be normally distributed. The one-sided component Ui, captures randomness under the control of the firm. It gives the deviation from the frontier attributed to inefficiency. It is assumed to be either half-normally distributed or exponentially distributed. By definition, stochastic frontier production function is Yi =F (Xi; ß) exp (Vi – Ui) i = 1,2, ., N (1) Where Yi is the output of the ith firm; Xi is the corresponding (MX2) vector of inputs; ß is a vector of unknown parameter to be estimated; F(.) denotes an appropriate form, Vi is the symmetric error component that accounts for random effects and exogenous shock; while Ui = 0 is a one sided error component that measures technical inefficiency.

Methodology

Anambra State is the study area. The state is located between latitude $5^0$38'N and $6^0$47'E of the equator and longitude $6^0$36'N and $7^0$21'E of the Greenwich Meridian. The state is bounded in the east by Enugu State, in the West by Delta State, in the South by Imo State and in the North by Kogi State. Anambra State has Awka as capital with population figure of 4.184 million people (NPC, 2006). It has four agricultural zones; Anambra, Awka, Onitsha and Aguata. The state has numerous streams and tributaries flowing into River Niger. Anambra State has a mean temperature of 28 – 38^0C and rainfall of 1500 – 2500mm.

Purposive and multistage random sampling techniques were used to select Local Government Area (LGA), towns, villages and catfish farmers. In the first stage, five Local Government Areas were purposively selected because of intensive catfish production in the areas (Nwosu et al, 2005). The selected LGAs were Anambra, Oyi, Awka North, Onitsha South and Oyi. In the second stage, four towns were randomly selected from each of the LGAs. This brought to a total of twenty towns. In the third stage, six villages were randomly selected from each of the towns, totaling one hundred and twenty villages. Finally, a catfish farmer was selected from each villages and a total of one hundred and twenty were selected for detailed study. Well structured questionnaire was administered to each of the sixty farmers to collect information on input and output quantities used and their unit prices, farmers' socioeconomic characteristics and other essential information as related to the study. Percentage was used to discuss the socioeconomic characteristics of the farmers. The farmers' technical efficiency and its' determinants were addressed using Cobb Douglas stochastic production function. Cobb Douglas is widely used in frontier production function studies in most developing agriculture than any other production functional forms (Coelli, 1995)).

The Cobb Douglas frontier production function is specified by (5) as follows:

$$\text{In } Q = \beta_0 + \beta_1 \text{ In } x, + \beta_2 \text{ Inx}_2 + \beta_3 \text{ Inx}_3 + \beta_4 \text{ Inx}_4 + \beta_5 \text{ Inx}_5 + V_1 + U_1 \ldots\ldots(1)$$

Where Q = quantity of cat fish produced by farmer (kg), X_1 = fish seeds (No); X_2 = feed (kg); X_3 = labour Input (man days); X_4 = plot size (m^2); X_5 = depreciation (N), V_i = random error and U_i = technical efficiency.

In order to determine factors contributing to the observed technical efficiency, the following model was formulated and estimated jointly with stochastic frontier model in maximum likelihood estimation procedure using the computer software frontier version 4.1 (Aigner, et al 1997).

$TE = a + d_1 m_1, + a_2 m_2 + a_3 m_3 + a\ m_4m_4 + a_5 m_5 + a_6 m_6 + a_nm_n.$

Where TE = Technical efficiency, M_1 = age of the farmers (years), M_2 = educational level (years), M_3 = farming experience (years), M_4= household size (Number), M_5 = Extension visit (Number), M_6 = membership of cooperative (1 = members, 0 = nonmember), $a_o – a_6$ are parameters to be estimated.

Results and Discussion

The average statistics of the sampled catfish farmers is presented in Table 1. On the average, a typical catfish farmer is 46 years of age with 12 years of formal education, household size of about 6 persons, 10.4 years of farming experience, farmed 6.4 ponds, employed 34.78 mandays of labour and produced an output of 284. 54 of fish per annum

Table 2 showed that the estimated square of the total variance was significantly different from zero at 1% alpha level, this give credence to the goodness of fit of the model and the correctness of assumption of the composite error term. The variance ratio parameter (λ) was 0.7862 and statistically significant at 1% probability level. This indicates that 78.62% of the total variation in catfish output was due to technical inefficiency. This implies that the variation in actual output from maximum output between farms mainly arose from differences in farmer-practices rather than random variability. The coefficient of fish seed, feed and labour inputs had the desired positive signs and statistically significant. This implies that increase in any of the variable will increase the output of catfish farmers. The coefficient of plot size was negative against a prior expectation, implying that the more the increase in pond size used, the less the number of fish produced. The determinants of technical efficiency in cassava were shown in table 3. The coefficient of level of education was positively related to technical efficiency and significant at 1% risk level. Educational attainment according to Ume and Okoye (2009) is a desirable condition for agricultural development, since it augured well for extension services in transferring research result for sustainable food production. More so, the coefficient of the farming experience had a positive effect on the efficiency of the catfish farmers and significant at 5% alpha level respectively. The number of years of farming experience could mean higher farm output. This could be attested to the fact that the number of years a farmer has spent in a farming business may give an indication of the practical knowledge he has acquired on how he can overcome certain inherent problems as well as to improve in his managerial ability and decision in his farm operation (Okoye and Onyenweaku 2010). Nevertheless, studies show that experienced farmers are poorly adaptive individuals as they believe much in the old order to avoid risks and uncertainties associated with new innovations (Eze and Akpa, 2010). The coefficient of extension contact as expected was positive in line with a priori expectation and significant at 5% alpha level. Unammah, (2003) measured extension contact in terms of, frequency of visits of the extension agent to the farmer, vice-versa. Such visits according to them would enlighten the farmers and create a greater awareness for the potential gains of improved agricultural technology.

The statistical test of the coefficient of credit was negative and significantly related to technical efficiency at 1% risk level. The poor access of catfish farmers to credit facilities could be the explanation for the sign identity. This finding did not concur with Iheke, (2010)

The distribution of the efficiency estimates obtained from the stochastic frontier is presented in table 4. The mean technical efficiency was 44.0 percent, which implied that the output of catfish can be increased by about 56% with the farmers' level of resources. This suggested that opportunities exist for increasing productivity and income through increased efficiency in resource utilization and use of improved technologies by catfish farmers in the study area. The production elasticity as shown in table 5 were all positive and with return to scale of 1.6951. This implies that the farmers are in stage II of production phase. This means that catfish farmers in Anambra State of Nigeria were either under or over utilizing their inputs.

Table 4, shows that majority (80%) of the farmers complained of high cost of feed. Ike *et al* (2003) reported that high cost and often unavailability of fish feed concentrate make fish farming unproductive. The effect is that farmers stop feeding their fish when the prices of feed are high and resume only when they can afford the cost. More so, Ejindu, (2003) stated that poor resource farmers resorts to use of poultry mash at period when fish feed becomes more costly. Furthermore, 65% of the fish farmers complained about poor fish breeds problem, which performances are uneconomical as they not only miss the market target but waste space and finance to the detriment of the farmers' profits. Furthermore, 60% of the respondents reported the problem of climate change. FAO,(2007) reported that the major effects of climate change on aquaculture would be through global warming and consequent temperature rises in water. This warming results in more frequent occurrences of harmful algal blossom that threaten cultivation of molluse. More so Nwosu, et al (2003) observed that the effect of climate change of captured fisheries are likely to have effect on aquaculture, such as damage to physical capital due to severe weather effect reduced human capital as result of severe weather, increased incidence of red tides and associated shell fish poisoning, decreased revenue to fisher, resulting to decline in catch and stock abundance and the effect on marketing chains/ systems as result of storm.

Poor access to credit was complained by 83.3 percent of the sampled farmers. The high interest rate as charged by te commercial and oter lending agencies in the country could be related to poor access to credit (Ume et al 2010).

Credit In addition, 56.7% of the respondents encountered the problem of poor access to extension services. The high ratio of extension agent - farmers and nonchalant attitude of the extension agents to their duties could lead to only a few handful which of farmers having access to innovation that could enhance their income and standard of living. Ume and Okoye, (2009) made similar finding. More so, problem of drug and administration was reported by 66.7% of the respondents. Drugs in most Africa markets are substandard and this situation imparts negatively in livestock industry in thethe region. Also, water pollution (60%) is commonly reported among catfish farmers especially those in water scarcity areas, who depends on motor tankers for water supply. The effect of water pollution is reduction of fish growth as result of reduction in feeding as well as high mortality rate of fish (Ranal, 2007).

Conclusion and Recommendations

The major conclusions drawn from the study were; age of farmer, educational level and farming experience were the major determinants of technical efficiency in catfish farmers in Anambra State. More so, catfish farmers in Anambra State had mean efficiency of 0.44% in their catfish production, which implies that there are still rooms for improvement. The constraints to catfish production in the study area were poor access to credit, poor fish breed, water pollution, problem of climate change and extension agent. Based on the results, the following recommendations were made:

(1) There is need to strengthen the current government policies on education such as the universal basic education, adult education and nomadic education.

(2) There is need to encourage new entrant, especially young and educated into catfish production in order to absorb the available labour force in the society.

(3) Farmers' access to credit access through micro credit bank and other financial institutions should be encouraged.

(4) There is need to bridge the wide between extension- farmers ratio through employment of more extension personnel. More so, the efficiency and effectiveness of the change agent should be enhanced through provision of motivations and other incentives.

(5) Government should assist farmers to have easy access to water by providing more bore holes in the area.

(6) Government and nongovernmental organizations should organise workshop, seminar and conferences on fish breeding to reduce the problem poor fish breeds common in the markets.

(7)

Table 1: Average Statistics of Catfish Farmers Anambra State.

Variable	Description	Mean	Standard Deviation	Maximum	minimum
X_1	Age of farmers	46.00	0.42	54.00	44.00
X_2	Educational level(yrs)	12.2	0.52	23.00	7.27
X_3	Household size(no.)	6.00	2.56	13.02	4.00
X_4	Farming experience(yrs)	10.4	0.55	16.07	3.00
X_5	Pond size(m^2)	3.5	0.54	0.64	0.27
X_6	Labour(manday)	34.78	4.04	72.40	3.47
X_7	Output(kg)	284.54	4.443	332.65	26.50

Source: Field Survey, 2015

Table 2: Maximum Livelihood Estimation of Douglas Stochastic Frontier Production Function

Production factor	Parameter	Coefficient	Standard error	T-value
Constant term	β_0	11.8877	0.7482	15.8884***
Fish seed	β_1	0.6707	0.0377	17.790***
Fish feed	β_2	1.1982	0.4263	2.8106**
Labour input	β_3	0.5111	0.0992	5. 1150***
Pond size	β_4	-0.0993	0.9600	-0.1034
Depreciation	β_5	0.0097	0.0129	0.696
Diagnostic Statistics				
Total variance	$б^2$	0.7942	0.3461	2.2947**
Variance ratio	Y	0.9957	0.0664	14.995***
Likelihood ratio test	-	421.2610		
Log likelihood function	-	5.7855		

Source: Computed from Survey Data, 2015.

***, **, * statistical significance at 1%, 5% and 10% respectively.

Table 3: Estimated Determinant of Technical Efficiency In Cat fish Farmers in Anambra State.

Determinants parameters		Coefficient	Standard error	t-ratio
Constant	α_0	12.0810	2.6540	4.5519***
Age of farmers	α_1	-0.6640	0.7881	-0.08425
Educational level	α_2	2.8346	0.45061	6.2907***
Household size	α_3	0.0069	0.0149	0.4631
Farming experience	α_4	1.2367	0.4645	2.6629**
Membership of coop	α_5	0.0251	0.0042	0.402
Credit access	α_6	-6.7921	0.5320	-12.7667***
Extension contact	α_7	0.8470	0.7952	1.0651*

***, **,* statistical significance at 1%, 5% and 10% respectively.

Source: Computed from Survey Data, 2015.

Table 4: Distribution of respondents according to Technical Efficiency Index

Technical efficiency index	Frequency	Percentage
0.21 – 0.30	10	8.3
0.31 – 0.40	6	5
0.41 – 0.50	14	11.7
0..51 – 0.60	15	12.5
0.61 – 0.70	30	25.
0.71 – 0.80	35	29.2
81 – 0.90	10	8.3
Total	120	100
Maximum technical efficiency	=	0.97
Minimum technical efficiency	=	0.24
Mean technical efficiency	=	0.44
Mean of best 10	=	45.4%
Mean of worst 10	=	81.4%

Source: Computed from survey data, 2015.

Table 5: Elasticity and Return to Scale for Cassava Production

Inputs	Elasticity
Pond Size	-0.0993
Fish feed	1.1985
Labour	0.5111
Fish Seed	0.6707
Depreciation	0.0097
Return to scale	1.6951

Source: Computed from Survey data, 2015.

Table 4: Constraints to catfish production in Anambra State

Variable	Frequency	Percentage
Drugs and medication	80	66,7
High cost of feed	94	78.4
Poor fish seed breed	78	65
Poor access to credit	100	83.3
Water pollution	72	60
Marketability	52	45
Pests and Diseases	24	20
Pond Management	50	41.7
Climate Change	72	60
Poor access to Extension sevices	68	56.7

* Multiple responses

Source: Field survey, 2015

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