EFFECIENCY OF RESOURCE USE IN FISH FARMING: IMPLICATIONS FOR FOOD SECURITY IN BENUE STATE

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ABSTRACT

In spite of Nigeria's efforts over the years to guarantee food security, evidence on ground reveals that the food insecurity virus is getting more entrenched in the country. In view of this, the study examined the extent to which fish farming can be used to reduce food insecurity in Benue State. Data were collected using well-structured questionnaires. The stratified random sampling technique was used to obtain 80 respondents in the study area. Data generated were analyzed using descriptive statistics and Cobb-Douglas production function to determine the efficiency or otherwise of resource use in fish farming. In this regard, the logarithmic linear multiple regression model was estimated using the Ordinary Least Squares (OLS) technique. The result of the adjusted R of 0.62 implied that the explanatory variables accounted for 62.0% variation on the dependent variable. Also, the F-Statistic value of 20.881 is significant at 5% significant level, implying that efficient use of resources impact positively on the output level of fish. It was however noted that efficiency of resource use is not the major determinant of food security in the study area and this is shown by the insignificant values (except that of cash expenditure) of the t-statistics. The results showed among other things, that the farmers were operating in stage I because MPP values are greater than APP values (i.e MPP>APP), implying that the farmers were *technically inefficient in the use of inputs. Also, the MVP of the factor inputs was greater than their marginal costs (MFC), implying that these inputs were not optimally utilized. It is suggested in the study that government should provide improved fish species, provide loans and educate farmers in the fight to reduce food insecurity.*

Keywords: Resources use, Fish Farming, Food Security, Cobb-Douglas Production Model, Basic Resource Theory.

Introduction

Available and relevant literature on the Nigeria economy shows that agriculture is the backbone of the nation's economic and political sovereignty. This explains why successive governments in Nigeria have taken various steps to encourage food production in the country. The need to increase food production is emphasized in relation to the population explosion in the country from 55 million in 1963 to about 180 million people in 2013 (Federal Office of Statistics, 1994; National Population Commission, 2006).

According to Abu, G. A; Agbo, S.O and Ater, P.I. (2004), both population increase and the general fall in the production of some staple foods have worsened the food shortage situation such that the country experienced serious food crisis during the early eighties. In the past two decades, the per-capita food production in Nigeria has declined tremendously. This has had adverse effects on both the economy and the human populace. The food problem stems from the inadequacy of domestic food supplies to meet internal demands (Shaib, B; Aliyu, A. and Bakshi, J. 1997; Adewumi, M.O; Ayinde, O.E; Oladeinde, O.A and Muhammad, L.A. 2004).

Fish holds the potential of reducing protein deficiency in the country. It provides a substantial proportion of animal protein in human diets. It constitutes 17-50 percent of the world's animal protein intake while it contributes about 40 percent of animal protein intake of average Nigerians (Adewumi, 1994). However, fish farming is usually faced with prevalence of disease, shortage of feed, inadequate manpower. With a high content of polyunsaturated fatty acids, fish protein is known to be superior to beef protein and it is important in lowering blood cholesterol level (Kent, 1984). However, the role of fish as a major supplier of protein can only be achieved through optimum consumption by the people.

Sequel to the above, it means anything which hampers or reduces production of fish invariably reduces availability of the essential nutrients to deserving people. It is based on the importance of fish that it becomes imperative to examine the efficiency of farm resources in its production.

The fish farming activity is a recent development in Benue State. Pilot fish farms were established in the state and these were to afford the private investors the opportunity to view the first hand socio-economic merits of operating fish farms. Operations of these projects have not been successful due to inadequate manpower, high initial capital cost of inputs procurement. The farmers also do not measure their efficiency and elasticity of production, neither do they measure yields produced from other fish farmers. Other limiting factors to the farming include inadequate capital, insufficient supply of fingerlings and improper legal framework (Adzer, 2010).

According to the CBN survey of 2006 output of fish, there was an increase of 4.7 percent above its output level in 2005 to 600,000 tones. The production of table fish through fish farming also increased from 30,000 tones to 80, 000 tones in the same period. The 2006 production level of 0.6 million tones was much lower than the national demand of 1.5 million tones. It is on this note that the study assesses the need for fish farmers to expeditiously utilize farm resources in order to improve productivity, enhance income generation and also meet the food demand of the people through fish farming.

To Olayide and Heady (1982), inefficient resources use among small scale farmers is one of the major causes of poor agricultural production. To Koutsoyiannis (1979), a sector or enterprise which uses its resources inefficiently, characterized by low value of marginal product is likely to loose its resources to those industries or sectors with high value of marginal products (VMP).

The study therefore describes the socio-economic characteristics of fish farmers in the study area and also assesses the productivity of the resources employed by the fish farmers and the implication of the findings to the state and Nigeria at large. The elegance of the choice to assess the productivity of agricultural inputs is that, all things being equal, enhanced productivity guarantees food security. It is on this note that the study assesses the need for fish farmers to expeditiously utilize farm resources in order to improve productivity, enhance income generation and also meet the food demand of the people through fish farming.

The broad objective of the study is to examine the efficiency of resource use as a determinant to food security in the study area. Specifically, the study seeks to assess (i)the benefits of fish farming in the study area (ii)the productivity and efficiency of resource use in fish farming (iii)the problems faced by fish farmers in the study area (iv)the implication of the findings to the study area.

It is hypothesized in this study that there is no significant effect of efficient resource use in fish farming of on output level of fish.

Conceptual and Theoretical Framework

Fish farming is the raising of fish culture principally practiced in ponds, cages and pens such that it permits the supervision and regulation of production, feeding, quantitative growth and control of the size of the fish as well as the stocking and maintenance of the ponds instead of leaving this to nature (Aiyedun, 2004). To Ajekigbe (2007), fish farming is the rearing of fin in restricted water body. It includes the cultivation of shell fish (shrimps and oyster) in restricted water body. This cultivation is aimed at achieving the highest possible fish production in any given circumstances and in the most economic manner. The environment must be such that there is complete control over the physical, chemical and biological factors, which directly affect the rate of production. Adzer (2010) posits that fish farming is the production or rearing of fish done in conditions where all the basic means of production can be controlled within their respective limitations and from which producers aim to obtain optimal economic results.

Food security on the other hand, has been variously conceptualized. As such, Idachaba (1993) defined food security as not necessarily meaning self sufficiency in food supply. It refers to availability of food stuff in desired quantity and quality to all consumers throughout the year. According to Eicher (1984), food security is the ability of a country to assume on a long term basis that food system provides the total population access to timely, reliable and nutritionally adequate food supply. Food security according to the World Bank Summit held in Rome, Italy in 2006 among other things is the right of everyone to have access to safe and nutritious food, consistent with the right to adequate food and the fundamental right of everyone to be free from hunger.

The concept of efficiency of resource-use can be explained using the production function analysis. According to Olayemi and Olayide (1981), a production function is a mathematical model which expresses the technical relationship between inputs and outputs. That is, a production function defines the factor-product relationship in the production process. It defines the range of technical possibilities in the production process. Heady and Dillion (1994) assert that production is a pure technical relation; it describes the laws of proportion, that is, the transformation of factors into product (output) at any particular time or period. The production function represents the technology of a firm or an industry of the economy as a whole. To Olayide and Heady (1982), technical efficiency and allocative efficiency are two important concepts relating to production function. Technical efficiency refers to the ability of producer to obtain a certain level of outputs, while allocative efficiency is the ability to choose the level of inputs that maximizes profit at a given factor cost.

Theoretical Framework

The basic resource theory and the production function theory have been used here to explain how efficiency of resource use in fish farming can be used to enhance food security in the study area.

The Basic Resource Theory posits that economic growth depends on the presence, quality and the magnitude of basic natural resources within a particular economic region or area. The theory further argues as contained in Ogwumike (1995) that, development of these resources attract investment capital to these areas and increase employment and income. It has been argued that regions or areas where basic resources abound usually attract higher levels of income and grow at a faster rate than regions or areas without these resources. According to Ker (2006), even the construction of road networks, railways and other basic facilities is a function of the presence of basic resources in such areas. Therefore, fish farming should be encouraged as a means to reduce food insecurity in Benue State since the state has the required farm lands that support fish farms, and the availability of water bodies delivered naturally that supports both seasonal and perennial fish farm practices.

The production function theory looks at the relationship between inputs and output in the production process. Jhingan (2006) posits that the production function expresses a functional relationship between quantities of inputs and outputs. It shows how and to what extent output changes with variations in inputs during a specified period of time. To Olayide and Heady (1982), the production function stipulates the technical relationships between inputs and outputs in any production schema or processes. In mathematical terms, the function is assumed to be continues and differentiable. Its differentiability enables us to establish the rates of return.

Since the production function is assumed to be continues, the farmer will produce as along as he is able to cover the variable cost i.e. where the marginal cost (MC) is equal to or greater than average variable cost (AVC) i.e. $MC \geq AVC$. In a single input case, the optimum point of resource-use is where the value of the product is equal to input price (i.e. $MVP=Px$).

The production function depicts three stages of production. Stage I of production ends with the extensive margin. In stage II, the TPP first increases at an increasing rate. In this stage MPP increases and reaches maximum and begins to decrease. APP is also increasing till it reaches a peak and lies above MPP. At the end of stage I and the beginning of stage II, $APP=MPP$ (Heady and Dillion, 1994).

The stage II begins at the extensive margin where TPP continues to increase at a decreasing rate. At this stage the $APP>MPP$ and both APP and MPP are decreasing. At this stage also MPP meets APP at its maximum and where $MPP=0$ i.e. the boundary of stages II and III. Stage III of the production lies beyond the intensive margin where TPP is decreasing and MPP is negative (Abu et al, 2004).

According to Heady and Dillion (1994), in stage III the ratios of the variable inputs to fixed inputs are large and reach its maximum of the intensive margin. At this stage of the production, APP>0 i.e. positive and MPP<0 i.e. negative implying that APP is still positive but MPP negative. Therefore, the area of operation is stage II where the ratio of the variable inputs to fixed input is higher such that adjustment between the two extremes is possible. Stage II is the rational stage of production while stage I and III are irrational stages of production. This is because the maximum APP of a variable input occurs at the intensive margin whereas the maximum APP of fixed inputs is at the extensive margin. As long as MPP is greater than APP, the producer will continue to add more of the variable input. In other words, production concentrates on the range of output over which the $MPPK,_{L}$, although positive, decrease i.e. the range of diminishing but non-negative productivity of factors of production.

The production function is better linked to the Cobb-Douglas production function. This is because the Cobb-Douglas production function is a special case of production, which takes the form:

$$Q = \beta_0 K^{\beta 1} L^{\beta 2} e^{u} \quad \text{..} (1)$$

Where Q is the output, while β_1 is the elasticity of output (Q) with respect to capital (K) and β_2 is the elasticity of output (Q) with respect to labour (L). In this type of production function, the sum of elasticities, β_1 and β_2 gives the degree of homogeneity of degree 1 of the function. It exhibits either constant, decreasing or increasing marginal productivity.

Empirical Review

Adewuni et al (2004) conducted a study on an empirical analysis of fish farming in Ogun State of Nigeria. The Abeokuta zone of Ogun State Agricultural Development Projects (OGASEP) unified extension services was purposely selected due to the fact that fish farming business are majorly embarked upon by the people in the zone. The study used primary data collected with the aid of structured questionnaires. They also used descriptive statistic, multiple regression analysis and the farm budget analysis. The double-log production function was used and the equation explained 97.5% of the variation in fish output. They concluded that the variability in fish output was explained by pond size, quantities of fertilizer, lime, finger-lings and labour used.

In analyzing the impact of economic efficiency of resource use on production in traditional agriculture, Olayemi (1974), using primary data collected in Kwara State estimated the marginal products of some production inputs and the use of these in the evaluation of the economic efficiency of small-scale rice producers. The study revealed that Land, Fertilizer, Seeds, Irrigation as resources were grossly underutilized. For instance, he pointed out that improved seeds would generate an incremental revenue of ₦ 42.31 on an incremental revenue of about ₦18 per acre. This shows that their value marginal products were less than output prices. An increment on their costs would have yielded incremental revenues. Labour inputs, both hired and family labour, were on the other hand, found to be overutilized. For instance, one incremental man-day of family labour valued at ₦ 0.60, yielded only ₦ 0.26 in incremental revenue. The study also showed sum of the elastic ties of 1.154 to be statistically greater than unity thereby implying increasing returns to scale.

In a similar manner, Abu et al (2004) conducted a study on efficiency of resource use in tomato enterprises in Tarka Local Government Area, Benue State-Nigeria. Their aim was to identify the problems facing tomato farmers in the study area and to determine the productivity and efficiency of resource use in tomato production. The Cobb Douglas production function was used in estimating the relationship between input and output and it showed that land, labour and capital were significant at 5% level of probability. Their study also showed that the value of marginal product of inputs were greater than their marginal cost, implying that these inputs were not optimally utilized.

Methodology

The study area, Benue State, was created in 1976 by late General Murtala Muhammed. The state lies in the middle belt geo-political zone of Nigeria and shares boundaries with Nassarawa to the north, Taraba to the east, Cross River to the south, Enugu and Ebonyi to the south and Kogi to the west. The state also shares an international boundary with the republic of Cameroon to the south-east.

Going by the 2006 population figures of 4,219,244, Benue State now has an approximate population of 5,189,137 million people and occupies a landmass of about 30,955km^2. The study is narrowed down to Makurdi and Gboko metropolis in the Zone 'B' Senatorial District. This is because fish farming is predominantly done in this area. The Makurdi metropolis according to Akighir and Nomor (2013) is comprised of Gyado-villa zone, Wurukum, North Bank, Wadata, High Level, Owner Occupiers' Quarters, Modern Market side, Nyiman Layout, Judges Quarters and Terwase Agbadu. In a similar way Gboko metropolis is comprised of Yandev Area, Gboko West (Express Road side), Low-cost Housing Estate Area, Adekaa zone, Gboko South Area, Gboko Central zone, Abagu Area, Rice mill Area and Gboko Government Reserved Area. The population frame in the study area was arrived at following a reconnaissance survey of Adzer (2010), where about 140 fish farms were identified four years ago. Sequel to this, in Makurdi metropolis a stratified random sampling procedure was used to select 40 farmers from the strata. That is, 30 farmers were selected from Wadata and 10 farmers were drawn from Nyiman Layout. In Gboko metropolis, the same procedure was used and 20 farmers were drawn from Gboko West (Express Road side), 15 farmers Low-cost Housing Estates Area and 5 farmers from Rice Mill Area. The reasons for the selection is explained in terms of the good topography in areas farmers were found and inadequate farm space or poor topography in areas farmers were not found. The implication here is that, some strata may be assigned more weight (presence of farmers) and others less weight (absence of farmers), but irrespective of their weights in the sample, each stratum carries the same weight as corroborated by Doki (2013).

The harvested fish were valued at the prevailing producer price of ₦700 per kilogram weight. The average physical product of inputs, APP and values of marginal physical product MPP were obtained in the study. Also, the marginal productivity coefficients, Ex, of the elasticity of dependent variable Y with respect to independent variable X were obtained. The implication was to enable the researchers make a comparison of the values of marginal physical products (MPPs) and values of average physical products (APPs) in other to determine the efficiency or otherwise of resources used in the study. A comparison of the values of marginal physical products (MVPs) and their corresponding marginal costs (MFCs) was also adopted to determine the efficiency or otherwise of resource use in fish farming in the study. The statistical value of the sum of the elasticity (Ex) was also used to ascertain the state of productivity of fish farmers in the study area.

The primary data were collected with the aid of well-structured questionnaires administered were based on the 2013 production season. The farming season is all year round spanning from the dry to wet season. The acres of land were assumed to be owners' land. Secondary data from existing literature relevant to the study were also used.

Descriptive statistics and the Cobb-Douglas production function analysis were used to realize stated objectives.

Model specification

The Cobb-Douglas production function was specified as:

$Q = ß_0 K^{ß1} L^{ß2}$, where variables remain as earlier stated.

Our traditional Cobb-Douglas production function is modified as:

$Q = ß_0 X_1^{ß1} X_2^{ß2} X_3^{ß3} X_4^{ß4} X_5^{ß5} X_6^{ß6} e^u$ ....(2)

Where Q = Output level

X_1 = Number of man-days of family labour

X_2 = Cash expenditure on hired labour (in Naira)

X_3 = Amount of fertilizer used (in kg)

X_4 = Fish variety (a binary variable)

X_5 = Fish farm size (in sq. meters)

X_6 = Amount of fish feed used (in kg).

$ß_1$-$ß_6$ = Vector of parameters to be estimated

$ß_0$ = Constant term

e^u = Disturbance term

The double logarithm of equation (2) gives us:

$$\ln Q = \ln \beta_0 + \beta_1 \ln MHRS + \beta_2 \ln CEXP + \beta_3 \ln AFERT + \beta_4 \ln FVAR + \beta_5 \ln FSIZE + \beta_6 \ln AFEED + \mu \quad \text{.........(3)}$$

where Q is the output level of fish, MHRS is the number of man-days of family labour, CEXP is the cash expenditure on hired labour (in Naira), AFERT is the amount of fertilizer used (in kg), FVAR is the fish variety (a binary variable), FSIZE is the fish size (in sq. meters) and AFEED is the amount of fish feed used (in kg). β_0 is the constant, β_1-β_6 are the parameters to be estimated and μ is the disturbance term.

The elegance of the log-linear model is to help reduce if not remove completely, the deleterious consequences of the heteroscedastic errors that might creep into both sides of the equation as agreed by Ekpo (1997), Amadi and Osaro (2000); and Ogiji and Akpan (2004). Also, since elasticities are required, transforming the model into logarithmic form will help us to obtain parameter estimates that are straightway elasticity estimates.

A priori Expectation: This is the expected behaviour of the coefficients in our model Thus, it is expected that: $X_1>0$, $X_2>0$, $X_3>0$, $X_4>0$, $X_5>0$ or $X_5<0$, $X_6>0$.

Rules of Thumb: Three rules of thumb have been used in study. There are:

a) If MPP>APP, we can conclude that there is inefficient use of resources, which suggests stage I but if otherwise there is efficient use of resources, which suggests stage II.

b) If MVP>MFC or MVP<MFC we can conclude that there is inefficient use of resources but if they are equal, we can conclude that the resources are optimally utilized as agreed by Olayemi and Olayide (1981).

c) If Ex<1, it shows diminishing returns to scale which suggests stage II, but if Ex>1 it shows increasing returns to scale which suggests stage I.

Result and Data Analysis

Table 1 shows the sources farmers obtain their fingerlings from, whether from government hatchery, owners' hatchery or from the wide (i.e river or stream).

Table 1: Sources of Fingerlings in the Study Area.

Sources	Frequency	Percentage
Government	10	12.5
Hatchery	44	55.0
Wide catch	26	32.5
Total	80	100.00

Source: Field Survey, 2013

The survey revealed that most of the fish farmers, representing 55 percent got their fingerlings from the hatchery while 32.5 percent got their fingerlings from the wide (i.e streams and rivers). 12.5 percent here reveals that the government is not encouraging fish farming in the study area.

Table 2 reveals whether people go into fish farming for profit motive, consumption or for leisure purpose.

Table 2: Reasons for Fish Farming in the Study Area.

Reasons	Frequency	Percentage
Profitability	60	75.0
Home consumption	15	18.75
Leisure/interest	5	6.25
Total	80	100.00

Source: Field Survey, 2013

The study showed that profitability is the main reason that attracted the farmers and this is represented by 75 percent. In as much as the main reason for fish farming is basically commercial, part of the fish is consumed and this is represented by 18.75 percent while 6.25 percent of the people engaged in fish farming for leisure.

Table 3 seeks to explain what those who farm for profit do with the proceeds, whether to reinvest it, maintain family or train children in school.

Table 3: Benefits Accrued from Fish Farming in the Study Area.

Appropriation	Frequency	Percentage
Investment	10	12.5
Maintain family	44	55.0
Train children in school	26	32.5
Total	80	100.00

Source: Field Survey, 2013

The survey revealed that most of the fish farmers, representing 55 percent use proceeds from their farm to maintain their family, while 32.5 percent of the farmers' income is directed to train children in school. Training children in school is *sine qua non* to development in the long run. Farmers who use proceeds from fish farming to invest into other profitable ventures account for 12.5 percent. Also, investment leads to economic growth, ceteries paribus.

Table 4 identifies the common problems faced by fish farmers in the study area; whether it is inadequate capital, inadequate technical services or source of fingerlings.

Table 4: Problems/Obstacles to Fish Farming in the Study Area.

Problem/Obstacle	Frequency	percentage
Inadequate capital	60	75.0
Inadequate technical services	5	6.25
Source of fingerlings	15	18.75
Total	80	100.00

Source: Field Survey, 2013.

The survey revealed that the most inhibiting factor of fish farming in the study area is inadequate capital representing 80 percent of the sampled farmers. The problem of unavailable hatchery sources representing 18.75 percent is another inhibiting factor to fish farming in the study area. Inadequate technical services represented by 7.5 percent are another barrier to fish farming in the study area.

Resource-Use Efficiency

Data collected about the respondents were analyzed using the Ordinary Least Square (OLS) multiple regression analysis to determine the relationship between inputs (i.e man-hours, cash expenditure, amount of fertilizer used, farm size and amount of fish feeds) and output of fish.

On the basis of the statistical and econometric criteria, the estimated log linear regression equation is stated thus:

$$lnQ = -0.907 + 0.141lnMHRS + 0.114lnCEXP + 0.082lnAFERT + 0.741lnFVAR$$

(0.819) (10.203) (1.128) (-0.278)

$$- 0.02lnFSIZE + 0.60lnAFEED \quad - - - - - - (4)$$

(1.863) (1.484)

Where figures in parenthesis are t-values

Adjusted R = 0.602

F-Statistic = 20.881

D.W. = 1.323

$$Ex = b_1 + b_2 + b_3 + b_4 + b_5 (0.141 + 0.114 + 0.082 + 0.741 + 0.60) = 1.678 \quad --- (5)$$

The sum of all elasticities obtained from equation (5) was 1.678 and this is found to be statistically higher than unity thereby indicating increasing returns to scale as suggested by economic theory.

From the study, it can be seen that the adjusted R is 0.602, i.e 60.2 percent and the F-statistic is 20.881 at 5 percent significance level implying that both are statistically different from zero and are therefore, significant, so the H_0 was rejected and the H_1 accepted that there is significant effect of efficient resource use on the output level of fish. This implies that efficient use of the farm inputs will result to increased output level of fish and hence food security in the study area.

The coefficients on MHRS, CEXP, AFERT, FVAR, FSIZE and AFEED have signs in accordance with the a priori expectation. A comparison of beta coefficients with their respective standard errors, show that coefficients on CEXP and FSIZE are significant while the other coefficients are not. The positive values of the coefficient exogenous variables also show that a higher value tend to increase the probability of a higher output level of the endogenous variable while the negative coefficient variable needs to be controlled since it impacts negatively on the endogenous variable.

The t-statistic values for the coefficient exogenous variables in our model are insignificant, except that of cash expenditure on hired labour. The significant t-statistic for cash expenditure could be explained that an extra Naira spent on this input yields additional revenue that is greater than the initial capital invested on the input whereas the other inputs do not.

The negative constant is tagged the 'participation level', implying that the more people participate in fish farming, the more food insecurity reduces. It also implies that when all individual explanatory variables are fixed, food insecurity (dependent variables) will decrease by approximately 9 percent, ceteries paribus.

Also, a test for serial correlation using the Durbin Watson (D.W) statistic, indicated the existence of significant positive (1.323) autocorrelation in the multiple regression model, probably, due to omitted variables.

The values of APP were obtained from an average of 203,860kg weight of fish was produced by eighty (80) farmers in the study area using a total of 950 man-hours, 350,000 Naira, 59kg of fertilizer, 184,3m^2 of land and 2000kg of fish feeds. The average physical product of these inputs was estimated to be:

App = $\frac{TPP}{X}$

Thus $App_{x1} = \frac{TPP}{X} = \frac{203860}{950} = 214.58$

$App_{x2} = \frac{TPP}{X} = \frac{203860}{350000} = 0.58$

$App_{x3} = \frac{TPP}{X} = \frac{203860}{50} = 4077.2$

$App_{x4} = \frac{TPP}{X} = \frac{203860}{184.3} = 1106.13$

$App_{x5} = \frac{TPP}{X} = \frac{203860}{2000} = 101.93$

In consonance with the elasticity estimates obtained from the logarithmic model, certain transformations were made to derive marginal productivity coefficients. By definition, Ex, the elasticity of dependent variable Y with respect to independent variable X is:

$Ex = \frac{dy}{dX} \times \frac{X}{Y}$

Thus, $\frac{dy}{dx} = MPP_{x} = E_{X}. \frac{Y}{X}$, where, X and Y were measured at their geometric or arithmetic means as the case might be. Hence,

MPP = Ex. APP

So MPP_{x1} =1.678×214.58 = 360.06

MPP_{X2} = 1.678×0.58 = 0.97

MPP_{X3} =1.678×4077.2 = 6841.54

MPP_{X4} =1.678×1106.13 = 1856.08

MPP_{X5} = 1.6758×101.93 = 171.03

Having obtained the marginal physical products of inputs that is, 360.06; 0.97; 6841.54; 1856.08 and 171.03 for man-hours for family labour, cash expenditure on hired labour, amount fertilizer used, fish farm size and amount of fish feeds respectively, they were also valued at the prevailing producer price of fish (i.e ₦700 per kg weight). A comparison of the values of marginal products with optimum level of performance where marginal cost is equal to marginal revenue was made as agreed by Olayemi and Olayide (1981). Given the level of technology and prices of both inputs and output, the marginal productivity is the yardstick for assessing the efficiency of resource use as corroborated by Adewumi et al (2004). That is, a given resource is optimally allocated when its MVP is equal to its acquisition price (MFC). Otherwise, it is not optimally allocated. There can economic optimum yield or optimal allocation of a resource only when production is pushed to the point where the marginal physical product (MPP) of every input used in production is equal to the ratio of its input price and the output price. That is, $MPP_n = \frac{Pn}{Py}$ or $P_y(MPP_n) = P_n$ for output and input price of product *n.*

Because the MPPs of inputs were valued at the prevailing product price of ₦700 per kilogram weight, the MVPs of man-hours, capital, amount of fertilizer, farm size and amount of feeds were estimated to be ₦252,042, ₦679, ₦4,789,078, ₦1,299,256 and ₦119,721 respectively.

The table below gives clearer illustration as shown.

Table 5: Comparison of APP, MPP, MVP and MFC.

Factor	APP	MPP	MVP	MFC
Man hours	214.58	360.06	252042	34.28
Cash expenditure	0.58	0.97	679	500
Amount of fertilizer	4077.2	6841.54	4789078	3.57
Farm size	1106.13	1856.08	1299256	5.71
Amount of feeds	101.93	171.03	119721	25.71

Source: Researchers' computation, 2013

The comparison of APP and MPP values confirm that the farmer is operating in stage I, that is all values of MPP are greater than those of APP (i.e MPP>APP), implying that the farmers are operating below the food sufficient level. This stage relates to increasing average returns because the TP curve or value increases at an increasing rate. At this stage of production, the fixed factor (i.e farm land) cannot be put to the maximum use due to the non-applicability of sufficient units of the variables factors. The economical and profitable stage of production is where the ratio of the variable input to fixed input is higher such that adjustment between the two extremes is possible. This is at stage II, where APP>MPP and both APP and MPP are decreasing but non-negative productivity of factors of production.

It can also be seen from the study that the MVPs of all variable inputs given as ₦252,042, ₦679, ₦4,789,078, ₦1,299,256, and ₦117,921 respectively are greater than their corresponding costs (₦ 34.34, ₦ 500, ₦ 3.57, ₦ 5.71, and ₦ 25.71) of obtaining additional units of their inputs. This means that an individual extra Naira spent on each input yields additional revenue that is greater than initial investment on the input. It was therefore, concluded that these inputs were grossly underutilized. To attain maximum output level (food security) and economic optimum, the fish farmers should increase the use of these inputs.

The study reveals that unavailability of improved fish variety, shortage of fish feeds, inadequate technical manpower, inadequate capital, are some of the basic problems faced by fish farmers in the study area. These challenges thus pose a serious threat to increased output level (food security) and proteins needed for the survival of mankind and economic stability.

The findings show that the farmers were operating in stage I because MPP values are greater than APP values (i.e MPP>APP), implying that the farmers were technically inefficient in the use of inputs. Also, the MVP of the factor inputs was greater than their marginal costs, implying these inputs were not optimally utilized. This means that, since the resources are not optimally utilized food security and the proteins needed by man cannot be guaranteed in the study area.

It suggested in the study that:

i. The government through Benue Agricultural and Rural Development Authority (BNARDA) should assist fish farmers in getting improved species of culturable fishes;

ii. The government should provide feed compounding firms so that farmers will stop buying foreign feeds at exorbitant prices that add to farmers' high cost of production;

iii. Micro-finances should be promoted and encouraged to give loans to fish farmers to improve their activities;

iv. Improve farmers' education on the skills required in profitable fish production.

v. Researchers can investigate into other factors in addition to efficient resource use that guarantee maximum output yield in fish farming.

References

Abu G.A; Agbo, S.O. and Ater, P.I. (2004). Efficiency of Resource Use in Tomato Enterprise in Tarka Local Government Area of Benue State, Nigeria. *Journal of Economic and Social Research, Vol. 3, No 1, Dec. 2004*.

Adegeye, A.J. and Dittoh (1982). *Essentials of Agricultural Economics.* Impact Publishers , University of Ibadan, Nigeria.

Adewumi, M.O (1994). Resource Productivity and Efficiency in Fish Farming Enterprises: The Case of Kwara State of Nigeria. *Journal of Rural Development and Administration 25 (2) Spring: 33-42.*

Adewumi, M.O; Ayinde, O.E, Oladeinde, O.A. and Muhammad, L.A. (2004). Economic Analysis of Fish Farming in Ogun State of Nigeria. *Proceeding of the 19th Annual Conference of FISON Ilorin, 29th Nov. – 3rd Dec. 2004; edited by Araoye, P.A., FSN – Lagos, Nigeria.*

Adzer, K.T. (2010). The Potential of Cottage Fish Farming as a Poverty Strategy in Benue State. *Unpublished M.Sc. (Economics) Thesis Submitted to the Post Graduate School, Makurdi, Benue State, Nigeria*.

Aiyedun, J.O (2004). Financial Analysis of Small-Scale Fish Farming Enterprises to Alleviate Poverty in Homestead. 2004 *FISON Conference Proceedings.*

Ajekigbe (2007). Fisheries Development in Nigeria: The Challenge and Prospects of Accessing Funds. *The 2007 FISON Annual Public Lecture.*

Akighir, D.T. and Nomor, D.T. (2013). Empirical Investigation of the Poverty-Fuelwood Consumption Nexus in Makurdi Metropolis. *Journal of Economic and Social Research, Vol. 5, No. 1, October, 2013.*

Amadi, S.N. and Osaro, O. (2000). Security Pricing and Nigerian Capital Market 1985-1994: Some Reflections. *African Journal of Business and Economics Research Vol. 1, No1.*

Central Bank of Nigeria (2006): Annual Report, 2006.

Doki, N.O. (2013). An Assessment of the National Poverty Eradication Programme: Evidence from Benue State. *Journal of Economic and Social Research, Vol. 5, No. 1, October 2013.*

Eicher, C.K. (1984). *Facing up to Africa's Food Crises in Sub-Saharan Africa.* Michigan State University Press.

Ekpo, A.H. (1997). Foreign Direct Investment in Nigeria: Evidence from Time Series Data. *CBN Economic and Financial Review, Vol. 35, No1.*

Federal Office of Statistics (1994). *Abstracts of Statistics*.

Heady E.O and J.L. Dillion (1994). *Agricultural Production Functions*. Iowa State University Press, Ames, Iowa.

Idachaba, F.S. (1993). Quoted in Aregbe, K.T. (ed) (1999). *World Food Day '1999' in Nigeria.*

Jhingan, M.L. (2006). *The Economics of Development and Planning.* 35th Revised and Enlarged E.d., Vrinda Publications (P) Ltd, Delhi-India.

Kent, G. (1984). National Fisheries Policies and Alleviation of Malnutrition in Ogun State. A Case Study of Abeokuta North and Odeba Local Government Area of Ogun State. *Unpublished Thesis.*

Ker, G. (2006). Informal Microcredit and Poverty Reduction in Rural Communities in Benue State. *Unpublished M.Sc (Economics) Thesis Submitted to the Post Graduate School, Benue State University, Benue State Nigeria.*

Koutsoyiannis, A. (1979) *Modern Microeconomics.* Macmillan, London, 2nd ed.

National Population Commission (2006). *Census in Nigeria Conducted in 2006.*

Ogiji, P. and Akpan, E.S. (2004). Implication of (Rural Pricing Pattern on the Incidence of Poverty in Nigeria (1979-2002). *JESR, Vol. 3, No. 1, Dec. 2004.*

Ogwumike, F.O. (1995). The Effects of Macro-level Government Policies on Rural Development and Poverty Alleviation in Nigeria. *Ibadan Journal of the Sciences, Vol. 1, PP.85-101.*

Olayemi, J. K (1974). Swamp Rice Production in Traditional Agriculture: A Case Study of the Kwara State of Nigeria. *The Nigerian Agricultural Journal, Vol. 11, No. 3.*

Olayemi, J.K. and Olayide, S.O. (1981). *Elements of Applied Econometrics.* Card Publishers, Nigeria.

Olayide, S.O. and Heady, E.O. (1982). *Introduction to Agricultural Production Economics.* Ibadan University Press, Ibadan , Nigeria.

Shaib, B; Aliyu. A. and Bakshi, J. (1997). Nigeria: National Agricultural Research Strategy Plan 1996-2010. *Federal Department of Agricultural Science, Federal Ministry of Agriculture and National Resources, Abuja, Nigeria.*

Tober, J.G. (1984). A Review of the Fishing Industry in Nigeria and Status of Fish Production Method and Future Growth Pre-requisition to Cope with Anticipated Increase in Production. *In Nigeria Institute of Oceanographic and Marine Research, Technical paper (17): 1-3.*