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Environment of Business and Catfish Production

Ogidi, Armstrong Emmanuel (PhD Student)
Department of Agribusiness & Management
Michael Okpara University of Agriculture, Umudike, P.M.B. 7267, Umuahia, Abia State, Nigeria
| Email: armstrongogidi@gmail.com | Phone: 08036228671; 07057240174

Abstract: *The agribusiness manager must understand the basic elements of its environment to properly maneuver them. The objective of this study was to describe the business environment of catfish production in Benue State, Nigeria. The study found out that one of the nine business environment variables included in the general model – accessibility to consultants/veterinary services – exerted significant influence on the catfish farm inefficiency level in Benue State. However, the variable exhibited negative sign implying that increased access to consultants lowers technical efficiency. This is contrary to a priori expectations that increased access to consultants/veterinary services leads to higher productivity. Thus, the study came up with the conclusion that, business environment (i.e. physical, social and institutional) factors do have effect on catfish production in Benue State, Nigeria. In order to have effective control over the inputs resources within the catfish business environment, efforts should be made by academics and managers to identify other environmental factors such as government/political/legal, economic, natural, suppliers, etc, that could pose serious threats. Improvement in the years of experience in catfish production business could be achieved if catfish managers attend trainings or demonstration farms at least once every year.*

Key words: *Agribusiness environment, business environment, catfish production, Benue State*

1. Introduction

Business environment of catfish production from the broader, all inclusive perspective accommodates physical, social and institutional components. Business environment is seen to contain factors that influence policy decisions and activities of catfish enterprise production-unit (also referred to as the technical core of the enterprise). According to North (1981) the environment is further separated into the physical/ infrastructural environment, institutional environment, and social/economic environment. There are many distinct but similar approaches available in categorizing business environment components. Idachaba *et al.* (1984) identified business environment components into three sets namely physical, social and institutional. A business firm gets human resources, capital, technology, information, energy, and raw materials from society (environment). It follows government rules and regulations, social norms and cultural values, regional treaty and global alignment, economic rules and tax policies of the government. Thus, a business organization is a dynamic entity because it operates in a dynamic business environment (Gluek, 1980).

In order to underscore the importance of environment of agribusiness, consider the situation of a football team, where the environment consists of the opposing team (i.e. competitor), the referee who dictates the game, the weather of the football tournament, the condition of the pitch, the fans, etc. The football manager must first study the opposing team to know their style of play, the kind of players to use for the type of pitch, the character of the referee, etc, before setting out for the tournament. If these elements are properly evaluated, the football team will have a better chance of winning the football match, if the manager's advice is adhered to. The agribusiness manager must likewise understand the basic elements of its environment to properly maneuver them. What is really important is that, the agribusiness manager should know that any factor or variable that is not directly used to produce his output or manage his business, but somehow influences his business objectives constitutes an environment of agribusiness.

1.1. Research Question

How does business environment comprising of physical, social and institutional factors influence catfish production in Benue State?

1.2. Objectives of the Study

The objective of this study was to describe the business environment of catfish producers in Benue State, Nigeria.

1.3. Statement of Hypotheses

H0: Business environment which comprises of physical, social and institutional factors do not have significant effect on catfish production in Benue State.

2. Concept of Agribusiness Environment

The Business environment of agribusiness from the broader, all inclusive perspective accommodates both the internal and external components (Ogidi, 2016). The internal environment presents enterprise *strengths* and enterprises *weaknesses*; while the external environment presents environmental *opportunities* and environmental *threats* – SWOT analysis (Ogidi, 2016). This implies that the environment factor plays a decisive role in determining the success, failure and even continued existence of the business organization (Ottih, 2006). Business environment is seen to contain factors that influence policy decisions and activities of catfish enterprise production units – also referred to as the technical core of the enterprise (Ogidi, 2016). However, the environment of agribusiness can be defined as those factors, institutions and infrastructures that exist outside the agribusiness firm that affects decisions, objectives and activities of the business (Ogidi, 2016). Under the business environment concept, three forces that constitute threat or opportunity to the catfish enterprise were examined in this study. These forces are: physical, social and institutional factors.

2.1. Physical factors

Almost by definition, the basis for development is infrastructure - physical infrastructure (transport, electricity supply, water, roads, etc.). Although the infrastructure sectors are diverse, what they have in common is that public policy has had a great deal to do with how these services are provided and financed in almost all countries (Jimenez, 1994). Agribusiness managers should be aware of the threats and opportunities associated with the trends in the physical environment. For instance, if water is not readily available near the catfish pond, the manager has to provide storage facilities for buying and storing water; if there is epileptic electricity supply needed to provide cooling/freezing rooms, the manager will have to procure processing facilities to smoke some of his fish to avoid spoilage. Thus, this study takes physical variables such as, roads, electricity supply and water supply into context, but the ability of management to cushion the catfish enterprise against the threats posed by these three items is what we want to measure. For this study, we will look at the following variables under the physical dimension of the business environment:

a) ROADS: ***Accessible roads to production unit***
Catfish producers are sometimes forced to sell their catch at low prices to avoid spoilage because of bad road networks to markets. Inaccessibility to good roads leading to markets is an issue the catfish farmer has to contend with {United Nations Industrial Development Organization (UNIDO), 2009}.

b) COST OF ENERGY: ***Cost of procuring alternative energy***
Both fresh farmed catfish and smoked catfish are traded within Nigeria; reliable numbers are difficult to attain due to the large amounts that are unreported (UNIDO, 2009). However, the cost of procuring processing facilities could be a strain to some catfish producers, especially the small scale producers. In order for the catfish farmer to reduce wastage; even though there exists epileptic electricity supply in the study area, there is the need for the procurement of fish processing facilities to smoke some of the harvested fish. This will reduce wastage and shock from the electricity supply item within the physical environment component that would have been used to freeze excess catfish.

c) COST OF WATER STORAGE: ***Cost of installing storage facilities for water due to unavailability of water supply***
Unavailable water supply can affect costs and quality of storage facilities. These storage systems enable catfish producers to store input resources like water. The fish production manager has to select and acquire technologies, equipment that can harvest, store and disburse water (UNIDO, 2009).

2.2. Social factors

There are patterns of social integration which influences patterns of resource utilization, and thus affect the condition of the environment, in a number of ways {United Nations Research Institute for Social Development (UNRISD), 1994}. The dynamics involved range from micro-level phenomena, which collectively have a large impact on environmental conditions, to changing national and international social and economic structures and environmental regulating institutions. Social structures largely determine the outcome of social-environmental relations (Punkari, Fuentes, white, Rajalahti and Pehu, 2007). In particular, the implication of social factors influences the production unit. This study will make use of the following social factor variables:

a) EDUCATION: ***Number of years spent acquiring formal education***
Managerial ability and entrepreneurship are hypothesized to improve with level of education; at present, most farmers' literacy could be considered adequate, but for improved farm management and use of new production technologies, a higher level of education is necessary (Panayotou *et al.* 1982). The willingness to take risks and innovate also may increase, with the level of education.

b) EXPERIENCE/MANAGEMENT: ***Years of experience in catfish production***
Experience in farming is thought to be an even more relevant indicator of managerial ability and hence of successful operation than either age or education (Panayotou *et al.* 1982). An experienced and skillful work force enhances rational decisions and fulfillment of project requirement (Paulson, Fondahl and Parker, 1992; Abdul and Abdul, 1999).

c) COLLABORATION: ***collaboration with model catfish farmers***
Failure to collaborate with model catfish farmers can increase the death rate catfish. Collaborations with model farmers can improve output for farmers (UNIDO, 2009). For the inexperienced farmer, it is pertinent to meet and gain skills and knowledge from the best farmers nearest to them.

2.3. Institutional factors

According to an institutional economist Commons (1931:651),

> *"if we endeavor to find a universal circumstance, common to all behavior known as institutional, we may define an institution as collective action in control, liberation and expansion of individual action."*

Institutions in his specification cover unorganized customs up to the organized management of social life, such as the family, the corporation, the trade association, markets, research and development institutions, the trade union, the reserve system, and the state. A feature common to all of them is control: ways to arrange individual actions as parts of collective action (Commons, 1931). Aoki (2001) specifies institutions to cover shared beliefs, endogenous rules of the game, and summary equilibrium representations of the policy processes. Institutions can be formal or informal. Norms (laws, acts and other statements formulating sanctions) and economic policy relating to accessibility to financial instructions for credit and government policy on research and fish technology are typical examples of formal normative institutions (Samuels, 1988). A specific set among these norms is that which defines constitutional rights and obligations. This study will concentrate on the following items of the institutional factor.

a) FINANCIAL INSTITUTIONS: ***Access to financial institutions for credit***
Availability of finance has been a major constraint to catfish farmers, because they are mostly unable to meet the collateral requirements of formal financial institutions.

According to CBN, by the end of 2005, only N8.5 billion, about 29.5% of the SMEEIS fund has been utilized of the N28.8 billion set aside by the banks for the purpose of financing small and medium industries, including micro-firms (Nigeria Vision 2020 Program, 2006). Inputs are sometimes available in subsidized form from government and donor/NGO-sponsored programs. However such programs usually do not cover the full demand of producers' financial needs. Short-term credit in the form of agricultural production loans are an option for financing input acquisition, as well as operating expenses throughout the cropping cycle. Other facilities such as overdrafts or revolving credit may also be appropriate depending on the risk profile of the producer (UIDO, 2010). One option is for lenders to evaluate the "stickiness" of relationships to assess whether or not direct financing of producers, or indirect financing of their suppliers or buyers, is most appropriate (Coon, Campion and Wenner, 2010). Fishers are very often poor and spend most of their income on immediate needs such as food leaving them unable to pay for capital items, the education of their children, medical services, clothing, transportation and other items. With little capital or net worth to put up as collateral, financial institutions deem fishers too high a risk, even at increased interest rates. This leaves artisanal fishers to depend on small personal savings, loans from friends, relations, money lenders and traders. There is very little recourse to formal financial institutions, although there are currently NGOs and several projects aimed at facilitating access to credit (UNIDO, 2009).

b) RESEARCH INSTITUTIONS: ***Cost of innovation/technology in fish production from research institutions***

The lack of capital investment is a major factor influencing the adoption of improved new technologies from research institutes and universities. Catfish producers rely on personal savings and on traditional sources of credit (relatives, friends, and money lenders) for investment capital. Nigerian aquaculture industry is too weak, technical training to promote advanced technologies is a gradual approach to the formation of a large industry scale (Tannet Business Development, 2012). The funds available at this level are limited and cannot meet the capital requirement of improved technology. As a result, catfish producers are unable to invest in new technologies that would raise productivity, allow micro-enterprises to expand and ultimately increase incomes (UNIDO, 2009). It is therefore necessary to ensure that improved fish production technologies that have been developed and disseminated are adopted, in order to increase fish production. While some scholars have stated that what is needed is to develop the technologies and make them available (Joshua and Omidiji, 2002), others insist that the transfer of technology would be more effective when there is a greater interaction among the developers (i.e. research institutions, universities, etc.), transfer agencies, and the farmers (Dlamini, 2003; Yap-Gnaore, Ehui and Shapiro, 1995). However, the crucial point is for the farmers to be able to afford any technology extended to them. A United Nations Development Programme [UNDP] (2004) report indicated that it was the inability of farmers to afford the technologies extended to them that made farmers to abandon their ponds. Rogers (2003) has added another dimension by stating that the adoption of technology can be affected by the way it is named and positioned.

c) MARKET INSTITUTION/INTERMEDIARIES: ***Availability of market intermediaries for catfish output***

Available and stable market will boost the development of the fish industry through a number of variable roles e.g. market services (information, intelligence reports, promotions, etc.), so as to ensure sustained and increased inflow of investments and input resources (Adedeji and Okocha, 2011). According to Adirika, Ebue and Nnolim (2009) market intermediaries are firms that aid the company in promoting, selling and distributing its goods to the final destination. They include middlemen, physical distribution firms, marketing service agencies and financial intermediaries. The extent to which these intermediaries are effective and efficient determine the degree of success achieved by the management in the maintenance of a viable fit, between its offerings and customers or target market (Adirika *et al.* 2009).

3. Methodology

3.1. Population and Sampling Procedure

The sampled population of the study is basically of catfish farmers in Benue State. A first attempt at a comprehensive, nationwide inventory of inland water resources was made by the Aquaculture and Inland Fisheries Project (AIFP) of the National Special Program for Food Security (NSPFS). According to this inventory, Benue State has 198 Catfish farms – the highest compared to other Northern States in Nigeria (FAO, 2007). Since the population of catfish farmers in Benue State is not more than 198, the study deemed it adequate to use the population as the sample size. Therefore, the sample size for this study remains 198 catfish farmers. The list of catfish farmers in Benue State obtained from FAO (2007) and Benue State Ministry of Agriculture was distributed across the zones as follows: 36 catfish farmers from Zone A, 119 catfish farmers from Zone B, and 43 catfish farmers from Zone C.

3.2. Data Collection Techniques

Primary data were utilized in this study, through the use of structured questionnaire. The primary data used in this study come from a questionnaire survey of 198 catfish producers in Benue State for the production year 2013/2014. The questionnaire set was carefully structured by taking into consideration factors critical to the quality of instrument developed. Secondary data from literature (e.g. FAO, 2007) were used to determine the population size for this study.

3.3. Validation and Reliability of Instrument

3.3.1. Validity of instrument using factor analysis (Kaiser-Meyer-Olkin and Barlett's Test of Sphericity)

The critical components in this study had *content validity* because an extensive review of literature was conducted in selecting the measurement items. However, *Construct validity* was determined using factor analysis. Twenty (20) experts on catfish production were requested to independently give their adequacy of the 13 items (see Table 1) with respect to the objectives of the study. Questions of the data collection instrument were scrutinized in terms of how relevant they are to the specific objectives of the study through pilot test.

Factor analysis indicates that the Kaiser-Meyer-Olkin (KMO) measure for catfish inputs and business environment factors is 0.770 with Barlett's Test of Sphericity (BTS) value to be 984.341 at a level of significance, p<0.01. From Table 1, thirteen (13) factors with Eigenvalue, 4.186; is greater than one (1.000) and accounts for 32.20 percent of the total variance for the study. Our KMO result (0.77) in this analysis surpasses the threshold value of 0.50 as recommended by Hair, Anderson, Tatham, and Black (1995).

This affirms that the sample and data are adequate for this study. The result obtained also has strong *construct validity*, because the thirteen (13) variable items (that is, Fingerlings [FING], catfish feeds [FEED], labor [LABO], pond size [POSI], Accessible roads to production unit [AROADS], Cost of energy [COSTPF], Cost of water storage [COSTSF], Number of years spent acquiring formal education [EDUCAT], Years of experience in catfish production business [EXPERI], collaboration with model catfish farmers [COLLABO], Credit obtained from financial institutions [CREDIT], Cost of innovation/technology in fish production from research institutions [COSTIN], Availability of market intermediaries for catfish output [AVLMKT]) were tested for correlation and it was found out that there was a high degree of measures between the measures of the same construct, indicating that correlation exists between them. Finally, the 13 measurement variable items have soundness, power and legitimacy to be used in this study.

Table 1: Component Factor Analysis for Catfish Inputs and Business Environment Variables as Opinioned by Experts (n=20)

s/n	Variables	Factor 1	Factor 2	Factor 3	Factor 4
CIV	**Catfish input variables**				
CIV1	FING	0.854			
CIV2	FEED	0.571			
CIV3	LABO	0.708			
CIV4	POSI	0.902			
PF	**Physical factors**				
PF1	AROADS		0.542		
PF2	COSTPF		0.585		
PF3	COSTSF		0.523		
SF	**Social factors**				
SF1	EDUCAT			0.536	
SF2	EXPERI			0.506	
SF3	COLLABO			0.723	

IF	**Institutional factors**	
IF1	CREDIT	0.635
IF2	CONSTIN	0.527
IF3	AVLMKT	0.664

Notes: KMO measure of sampling adequacy = 0.770; total variance explained = 32.20 per cent, Barlett's Test of Sphericity (BTS) = 984.341, Eigen value = 4.186, degree of freedom = 78, [FING] = Fingerlings, [FEED] = catfish feeds, [LABO] = labor, [POSI] = pond size, [AROADS] = Accessible roads to production unit, [COSTPF] = Cost of energy, [COSTSF] = Cost of water storage, [EDUCAT] = Number of years spent acquiring formal education, [EXPERI] = Years of experience in catfish production business, [COLLABO] = collaboration with model catfish farmers, [CREDIT] = Credit obtained from financial institutions, [COSTIN] = Cost of innovation/technology in fish production from research institutions, [AVLMKT] = Availability of market intermediaries for catfish output

3.3.2. Reliability of instrument using Cronbach Alpha test of reliability

Cronbach Coefficient Analysis was used to identify the items to be removed before the field study proper. Reliability is the stability, dependability, accuracy and predictability of a measuring instrument. It is also the accuracy or precision of a measuring instrument. The four (4) variables (i.e. catfish resource inputs, physical factors, social factors and institutional factor) are useful and will not be dropped from the research, because overall Cronbach Alpha (**α**) will increase to 0.721 for catfish resource inputs, 0.648 for physical factors, 0.716 for social factors and 0.586 for institutional factors, if the 13 items contained in the variables were to be individually removed from the overall input factor values (see Table 2). Table 2 also shows the effect on overall Cronbach Alpha if a variable item is to be deleted from the computation. Thus our 4 variables are highly consistent internally.

Correlation would be weak for item analysis purposes if $r < 0.3$; if such a situation occurs, then that item should be removed and not form a composite score for the variable in question. However, all variable items for this study appear to be useful and contribute to the overall reliability. A re-test of the entire study questionnaire data (n=174) gave the following Cronbach Alpha (**α**) values: 0.718 for catfish input variables, 0.622 for physical factors, 0.709 for social factors, 0.546 for Institutional factors and 0.792 for the whole scale. Thus, this indicates that the reliability pilot test (n=20) and overall sample test (i.e. re-test) are dependable (accurate) and further supports literature – a measuring instrument gives similar, close or the same result when different measures under the same conditions use it (Cronbach, 1951, Nunnally, 1978). However, Alpha coefficient of the whole scale, from the pilot test is 0.784 (see Table 2 below).

Table 2: Cronbach Alpha Scale Descriptions Pilot Test for Catfish Inputs and Business Environment Variables (n=20)

s/n	Variables (factors) and **ITEMS**	Total sample	
		Cronbach Alpha (α)	**Item-to-total correlation**
CIV	**Catfish input variables**	0.721	

CIV1	FING		0.491
CIV2	FEED		0.483
CIV3	LABO		0.545
CIV4	POSI		0.415
PF	**Physical factors**	0.648	
PF1	AROADS		0.424
PF2	COSTPF		0.568
PF3	COSTSF		0.593
SF	**Social factors**	0.716	
SF1	EDUCAT		0.584
SF2	EXPERI		0.424
SF3	COLLABO		0.526
IF	**Institutional factors**	0.586	
IF1	CREDIT		0.428
IF2	CONSTIN		0.465
IF3	AVLMKT		0.541
Alpha Coefficient of the whole scale		0.784	

Note: Re-test of the entire study questionnaire data (n=174) gave the following Cronbach Alpha (**α**) values: 0.718 for catfish input variables, 0.622 for physical factors, 0.709 for social factors and 0.546 for Institutional factors and 0.792 for the whole scale.

3.4. Data Analytical Techniques

Descriptive statistics in the form of average, standard deviation and range, were used to describe the business environment. *The objective* set out to explore the effect of business environment parameters (δ_i) on resource inputs. The sum of β_i coefficient estimates from the objective tells us if the catfish enterprise is operating in stage II of the production function graph or not. *The objective* was determined by observing the effects of business environment on catfish resource use in the Full Specification Model (consisting of both Model 1 and Model 2). The stochastic frontier model was originally proposed for the analysis of the panel data by Battese and Coelli (1995). However, a general (full specification) stochastic frontier production function for the cross-sectional data, which is considered in this paper, is defined by

$$Y_i = exp(X_i\beta + V_i - U_i)$$

Where:

Y_i = denotes the output for the i_{th} sample farm (kg)

X_i = represents a vector whose values are functions of inputs and other explanatory variables for the i_{th} farm

β = is a vector of unknown parameters to be estimated are assumed to be independent and identically distributed random

V_is = are assumed to be independent and identically distributed random errors which have normal distribution with mean zero and unknown variance σ_v^2 and

U_is = are non-negative unobservable random variables associated with the technical inefficiency of production, such that for a given technology and levels of inputs, the observed output falls short of its potential.

Technical inefficiency effect model proposed by Battese and Coelli (1995) is described by

$$U_{it} = \delta_0 + \delta_i Z_{it}$$

Where:

Z_{it}= is a vector of explanatory variables associated with the technical inefficiency effects of the t^{th} farmer

δ = is an vector of unknown parameters to be estimated

Battese and Coelli (1988) considered the maximum likelihood estimator which involves specification of the distribution of V_i and U_i. The random variables V_i and U_i are assumed to be mutually independent and independent of the input variables in the model. If U_i = 0, the assumed distribution is half-normal. Where outputs are expressed in logarithms, the technical efficiency of the i^{th} farm is estimated as a ratio of the observed to maximum feasible output, where the latter is provided by the stochastic frontier production. The measure of technical efficiency is given by

$$TE_i = exp(X_i\beta + V_i - \mu_i)/exp(X_i\beta + V_i)$$
$$TE_i = exp(-\mu_i)$$

If U_i = 0, the farm were 100 percent efficient. Maximum-likelihood estimates of the parameters in the model were obtained. The parametric model is estimated in terms of the variance parameters, $\sigma_s^2 = \sigma^2 + \sigma_v^2$ and $\gamma = \sigma^2/(\sigma^2 + \sigma_v^2)$ (Umeh *et al.* 2013). In case of cross-sectional data, the technical inefficiency model can only be estimated if the inefficiency effects U_i's are stochastic and have particular distributional properties (Battese and Coelli, 1995). Therefore it is of interest to test the null hypotheses that technical inefficiency effects, γ, are non-stochastic. The parameter, γ, has a value between zero and one, in such a way that it is desirable to test the null hypothesis of Ho: γ = 0 whether traditional production function is an adequate representation of the sample data. If so, the non-negative random variable μ_i is absent from the model. The generalized likelihood-ratio test statistic can be calculated from the logarithms of the likelihood function associated with the unrestricted and restricted maximum likelihood estimates for the special case in which the appropriate parameter is zero.

Test of hypothesis for the parameters of the frontier model is conducted using the generalized likelihood-ratio statistics, λ , defined by

$$\lambda = -2log[L(H_1) - L(H_0)]$$

Where: $L(H_0)$ is the value of the likelihood function for the frontier model, in which parameter restrictions specified by the null hypothesis, H_0, are imposed; and $L(H_1)$ is the value of the likelihood function for the general frontier model. If the null hypothesis is true, then λ has approximately a chi-square (or mixed square) distribution with degrees of freedom equal to the difference between the parameters estimated under H_1 and H_0, respectively.

The structure of the General Model is imbedded in the equation linking catfish output to resources (inputs) on one hand (Model 1) and inefficiency model (Model 2) on the other. In the inefficiency model, inefficiency effect is linked with the business environment. Business environment factors are captured, through variables that influence the welfare or performance of the catfish production in the study area. This study focused on the following business environment factors, i.e. physical, social and institutional factors.

$$LogY_i = \beta_0 + \sum_{j=1}^{4} \beta_j \, LogX_{ij} + (V_i - U_i)$$

$$\boldsymbol{lnY = \beta_0 + \beta_1 lnFING + \beta_2 lnFEED + \beta_3 lnLABO + \beta_4 lnPOSI + (V_i - U_i)}$$

…………………………………………………………………………………………… (Model 1)

Where:

Log or ln = natural logarithm;

I = sample of catfish enterprises

j = number of inputs and farm-specific variables

Y = represents yield of the catfish enterprises in kg

$FING$ = fingerlings used in production (kg); *a priori* expectation is positive

$FEED$ = quantity of standard feeds used (kg); *a priori* expectation is positive

$LABO$ = labor requirements (man-days); *a priori* expectation is positive

$POSI$ = pond size of fish enterprise (m^2); *a priori* expectation is positive

β_js = parameters of linear terms; j = 0, 1... 4 are parameters to be estimated

ln = Log of estimated values of inputs, output and error term

v_is = statistical errors and random shocks such as faulty equipments, low quality fish feed, errors in measurement; are assumed to be independent and identically distributed N (0, σ^2) random variables

u_is = error term measuring the level of inefficiency in production; are assumed to be independent and identically distributed non-negative truncations of the N (μ, σ^2) distribution.

The **inefficiency model** for the study is shown below;

$$U_i = \delta_0 + \sum_{j=1}^{9} \delta_j \, LogZ_{ji}$$

$$\boldsymbol{U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \cdots + \delta_9 Z_9} \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{(Model 2)}$$

Where:

U_i = inefficiency effect

Z_{ji}= Explanatory variables for the technical inefficiency effects for the i^{th} farmer,

δ_js = parameters of demographic and environment of business variables

Z_1= Accessible roads to production unit [AROADS] (Dummy: accessible roads to production unit =1, bad roads to production unit=0); *a priori* expectation is positive

Z_2= Cost of energy [COSTPF] (₦); *a priori* expectation is negative

Z_3= Cost of water storage [COSTSF] (₦); *a priori* expectation is negative

Z_4= Number of years spent acquiring formal education [EDUCAT] (yrs); *a priori* expectation is negative

Z_5= Years of experience in catfish production business [EXPERI] (yrs); *a priori* expectation is negative

Z_6= Collaboration with model catfish farmers [COLLABO] (Dummy: access to consultants/vets=1, No access to consultants/vets=0); *a priori* expectation is positive

Z_7= Credit obtained from financial institutions [CREDIT] (₦); *a priori* expectation is negative

Z_8= Cost of innovation/technology in fish production from research institutions [COSTIN] (₦); *a priori* expectation is negative

Z_9= Availability of market intermediaries for catfish output [AVLMKT] (Dummy: access to market institution/intermediaries = 1, scarce markets = 0); *a priori* expectation is positive

The generalized likelihood ratio statistic is computed as $\lambda = -2log[L(H_0)/L(H_1)]$, where, $L(H_0)$ and $L(H_1)$ are the likelihood functions evaluated at the restricted and unrestricted maximum likelihood estimator for the parameters. If the null hypothesis, H_0, is true, then the statistics has approximately a chi-squared distribution with parameter equal to the number of restriction imposed by H_0 and with the degree of freedom equal to the difference between the parameter estimated under H_1 and H_0 respectively. The value of the γ indicates the relative magnitude of the variance associated, with the distribution of inefficiency effects, U_i. If U_i in the stochastic frontier are not present or alternatively, if the variance parameter, γ, associated with the distribution of, U_i, has zero value, then, σ_u^2, in (model1) – (model 2) is zero and the model reduces to a traditional function with the variables, fingerlings, feeds, labor and pond size, all included in the production function meaning that inefficiency effects are not stochastic.

The functional form for the stochastic frontier is defined by Model 1. The function is modified version of a Cobb-Douglas model. It permits different levels of productivity associated with different proportions of fingerlings, feeds, hired labor and pond size. The Catfish output is expected to be influenced positively by the inputs mentioned earlier. They are expected to have a negative effect on the size of the technical inefficiency effects. Effective utilization of inputs would be achieved, which in turn, increases the technical efficiency of the catfish farmers.

Furthermore, within the *physical factors*, the following variables: accessible roads to production unit, minimum cost of procuring processing facilities and minimum cost of installing storage facilities for resources, are necessary in order for catfish farmers to have access to input providers at affordable prices from the business environment, which in turn, would help in the achievement of effective utilization of inputs. This increases the technical efficiency of the production unit. This is obvious, because if the physical environment experiences perturbation, it will be very difficult for the catfish farmer to obtain the necessary input resources because of bad road networks. There will be the problem of high cost of procuring energy. Lastly, there will be the problem of high cost of installing storage facilities for water due to unavailability of water supply in the study area. The three constraints mentioned above, will therefore reduce technical efficiency within the catfish enterprise, if not properly managed.

Social factors, in the form of, number of years spent in formal education, years of experience in catfish production business, and access to consultants/veterinary services, are expected to have negative effect on technical inefficiency. This is because, high number of years spent in acquiring formal education could help improve the managerial ability of the catfish farmer. Easy access to catfish consultants/veterinary services helps to prevent high mortality rate in the future and will ensure a high turnover rate from output. A move from inexperience to a highly experienced entrepreneur would eliminate fluctuations in the business cycle; the catfish enterprise will be free from interruptions and the farmer can carry on production, without interference from the social factor. Thus the catfish farmer enjoys unrestricted access to inputs, without stopping production at anytime.

Institutional factors, in the form of, access to financial institutions for credit, cost of innovations in fish production technology from research institutions and available markets for catfish output, are expected to also have a negative effect on technical inefficiency. The reason is that: Available markets for the catfish output would ensure continuity in production and reduce interruptions in the catfish business cycle. The use of improved technology (e.g. circulatory systems for fish farming, the use of fiber glass, oxygen pump, etc.) from research institutions and at a low cost would eventually reduce errors in production and increase production output. If the cost of acquiring these technologies is greatly reduced, the catfish farmer ends up spending less in trying to expand production (i.e. pond size). Easy access to credit could enable the catfish producer to buy and stock inputs in large quantities from the market. This is to prevent the incursion of inflation in prices of the inputs in the future.

The models defined earlier (i.e. Model 1 and Model 2) were proposed by Battese and Coelli (1995). The parameters of the model, i.e. the β_s, the δ_s and the variance parameters , $\sigma_s^2 = \sigma_u^2 + \sigma_v^2$ and $\gamma = \sigma_u^2/(\sigma_u^2 + \sigma_v^2)$ are simultaneously estimated using the method of maximum likelihood (Umeh *et al.* 2013). A more flexible functional form such as the translog model could have been used, but the number of parameters involved would have been considerably greater. The translog model includes squared form of the variables and interactions among the variables. The interaction terms may give rise to the problem of multicollinerity, which may lead to high standard errors of the parameters. In this case the consideration of individual t-tests may lead to omission of some important variables, resulting in misspecification of the model. Also, the individual coefficients of the explanatory variables in the translog frontier function are not directly interpretable.

4. Results and Discussion

4.1. Descriptive Analysis of Business Environment on Catfish Production

Descriptive statistics of resources data and business environment characteristics are presented in Table 3. The mean catfish yield across the full sample was 6.61 kg per m^2 which is in tandem with Ogundari and Ojo (2008) with a mean catfish yield of 6.20 kg per m^2. Across the sample, on average, catfish producers used, 0.09 kg of fingerlings per m^2, 6.78 kg of formulated feeds per m^2, 1.03 man-days of labor per m^2 and pond size of 641.81m^2.

The average response to the availability of accessible roads to production unit was 0.66, indicating that 66 percent of the sample were able to transport inputs (resources) on accessible good roads. Mean cost of energy was ₦1, 371.36. Mean response to the cost of installing storage facilities for water due to unavailability of water supply was ₦12, 400.00.

The number of years spent acquiring formal education on the average was 17.48, although there was wide variation, ranging from 6 to 34 years. This finding is in tandem with the study of Ogundari and Ojo (2008) indicating a range value of 6 to 21 years and an average of 15.71 years for schooling. The average response on years of experience in catfish production business was 3.61 years. On the average, access to consultants/veterinary services was 0.42, indicating that only 42 percent of the respondents had access to extension services in their catfish enterprise. The average response to credit obtained from financial institutions was ₦6, 689.66, while, on the average, cost of innovation/technology in fish production from research institutions was ₦11, 100.00. Average response on the availability of market intermediaries for catfish output was 0.49.

Table 3: Resources and Business Environment Characteristics (n=174)

Variable	**Mean**	**Std. Dev.**	**Min**	**Max**
Catfish Output (kg/m^2)	6.61	3.56	1.54	18.54
Fingerlings (kg/m^2)	0.09	0.05	0.03	0.25
catfish feeds (kg/m^2)	6.78	7.19	1.14	42.16
labor (man days/m^2)	1.03	1.69	0.47	14.90
pond size (m^2)	641.81	307.76	170.00	1600.00
Accessible roads to production unit (dummy)	0.66	0.48	0	1
Cost of energy (₦)	1371.36	3498.92	0	21000
Cost of water storage (₦)	12400.00	19276.69	0	74000

Number of years spent acquiring formal education (yrs)	17.48	3.35	6	34
Number of years spent acquiring formal education (yrs)	3.61	1.67	0	7
Collaboration with model catfish farmers (dummy)	0.42	0.50	0	1
Credit obtained from financial institutions (₦)	6689.66	17727.75	0	100, 000.00
Cost of technology in fish production (₦)	11100.00	16202.58	0	80,000.00
Availability of market intermediaries (dummy)	0.49	0.501	0	1

Source: Field Study, 2014

The mean catfish output from Zone B is 6.72 kg/m^2 is greater than the mean catfish output in zones A, C and pooled data. This is obvious because Zone B used more fingerlings (0.092 kg/m^2) in production compared to the other zones and even the pooled data. Another reason for this high output is that Zone B was able to utilize more catfish feeds (7.5 kg/m^2) more than the other Zones and pooled data. The same goes for labor and pond size utilization.

Zone B has 70 percent of its respondents with access to motorable roads, while 3o percent of the respondents hardly have access to transport resources through and from their fish farms. However, it seems that Zone B also takes more risks than the other zones and pooled data. For example, ₦1727.14 was the mean cost of energy spent on the catfish farm by Zone B farmers. The mean cost of water storage used by Zone B is ₦14900.00 more than the other Zones and pooled data.

Table 4: Resources Data and Business Environment Characteristics in Zones and Pooled Data

Variable	ZONE A **(Mean)**	ZONE B **(Mean)**	ZONE C **(Mean)**	POOLED DATA **(Mean)**
	n=33	**n=105**	**n=36**	**n=174**
Y (kg/m^2)	4.817	6.72	4.534	6.61
FING (kg/m^2)	0.087	0.092	0.086	0.09
FEED (kg/m^2)	5.174	7.500	5.849	6.78
LABO (man days/m^2)	0.855	1.160	0.776	1.03
POSI (m^2)	553.58	690.01	582.11	641.81
AROADS (dummy)	0.55	0.70	0.61	0.66

COSTPF (₦)	1189.88	1727.14	500.00	1371.36
COSTSF(₦)	5282.58	14900.00	11600.00	12400.00
EDUCAT (yrs)	17.45	17.91	16.25	17.48
EXPERI (yrs)	3.21	3.86	3.28	3.61
ACONS (dummy)	0.40	0.45	0.44	0.42
CREDIT (₦)	5424.24	8095.24	3750.00	6689.66
COSTIN (₦)	6257.58	13600.00	8305.56	11100.00
AVLMKT (dummy)	0.49	0.58	0.44	0.49

Source: Field Study, 2014

4.2. Influence of business environment on catfish production in Benue State
The result on Table 5 showed the output determinants of catfish farms in Benue State**,** which indicated that all the technical efficiency determinants (that is, fingerlings, standardized feeds, labour and pond size) is in tandem with *a priori* expectations: quantity of fingerlings used in production was positively related to the quantity of catfish yield realized; yield of catfish realized is positively related to quantity of standard feeds used; output of catfish produced is expected to be positively related to number of labour used in the catfish farm; and yield of catfish realized was positively related to the pond size.

The three variables out of four, that is, fingerlings, standardized feeds and pond size indicated statistically significant influence on the output of catfish in the area. The significant t-values of fingerlings, standardized feeds and pond size indicated that these three inputs were the major factors determining technical efficiency of catfish production in Benue State. Their respective slope coefficients had t significant ratios. The respective elasticities of fingerlings, standardized feeds and pond size with respect to a unit output of catfish (that is, per kilogramme output) in the farms were 0.17, 0.05 and 0.72 percents respectively.

Table 5: Influence of business environment on catfish production in Benue State (n=174)

		General Model
		(objective)
Variable	parameters	
Frontier Prod. Function		

Constant	β_0	0.391** (0.177)
FING (kg/m²)	β_1	0.171** (0.07661)
FEED (kg/m²)	β_2	0.0534* (0.0166)
LABO (man days/m²)	β_3	0.0353 (0.0207)
POSI (m²)	β_4	0.720* (0.0779)
Inefficiency effects model		
Constant	δ_0	0.141*** (0.0713)
AROADS (dummy)	δ_1	0.0127 (0.0133)
COSTPF (₦)	δ_2	-0.00216 (0.00344)
COSTSF(₦)	δ_3	-0.00175 (0.00263)
EDUCAT (yrs)	δ_4	-0.0506 (0.541)
EXPERI (yrs)	δ_5	-0.0127 (0.0263)
ACONS (dummy)	δ_6	-0.0631* (0.0182)
CREDIT (₦)	δ_7	-0.00207 (0.0031)
COSTIN (₦)	δ_8	-0.00315 (0.00252)
AVLMKT (dummy)	δ_9	0.00908 (0.00943)
Variance parameters		
Sigma-squared	σ^2	0.00222* (0.000286)
Gamma	γ	0.000311** (0.000137)

Note: *,** and *** indicate that the parameter is significant at the 1, 5 and 10%, respectively, figures in parenthesis are error values

This is supported by the finding of Ogundari and Ojo (2009). Their study demonstrated that the coefficients of fingerlings, standardized feeds and pond size were statistically significant. Increased inputs were the major determinants of catfish productivity in Nigeria. This is contrary to a study by Emokaro and Akunwe (2009) which indicated that feed consumed were, grossly over utilized, negatively related to output and insignificant.

The negative coefficients exhibited by business environment variables in the general model (see Table 5) indicate that an increase in these variable items would lead to a decrease in technical efficiency. The variance parameter, γ, is statistically significant and greater than zero, which suggests the relevance of technical inefficiency in explaining output variability among catfish farms. Estimated coefficients help to understand the determinants of sample catfish farms' technical inefficiency.

Accessibility to roads (AROADS), cost of energy (COSTPF), education (EDUCAT), experience (EXPERI), access to credit (CREDIT), cost of technology (COSTIN) and accessibility to market (AVLMKT) were not significant and therefore constituted weak determinants of production output. Collaboration with model catfish farmers (COLLABO) is significant and had a negative sign, implying that increased access to consultants lowers the output. This is contrary to *a priori* expectations that increased collaboration with model catfish farmers leads to higher productivity. However, it agrees with Ogundari and Ojo (2008) who reported the same significant and negative relationship between collaboration with model catfish farmers and technical efficiency in aquaculture farms in Oyo State.

The hypothesis tested states that, *"business environment which comprises of physical, social and institutional factors do not have significant effect on catfish farmers' technical efficiency in Benue State."* This implies that, *"technical inefficiency is not present in the relationship between business environment and catfish production"* and that omission of is equivalent to imposing the restriction specified in the null hypotheses, i.e. H_0: $\gamma = \delta_0 = \delta_1 = \delta_2 = \delta_3 = \delta_4 = ... = \delta_9 = 0$. When this restriction was imposed on the model represented by equation 1 and 2, the value of the logarithm of the likelihood function (LLF) reduces to 283.723. This provides generalized likelihood ratio (LLR) test statistic of 30.612, which is larger than the critical value of 16.274. Thus, we reject the null hypothesis of no technical inefficiency effects stated above; given the specifications of the stochastic frontier and inefficiency effect model (see Tables 6 and 7 below).

Table 6: Cobb–Douglas Production Frontier Functions with Log Likelihood Estimates and LR Test of the One Sided Error (n=174)

		Cobb-Douglas Frontier Production Function	**General Model**
Variable			
Frontier Production Function			
Constant	β_0	-42.882 (27.303)	0.391** (0.177)
FING (kg/m²)	β_1	25.370** (8.291)	0.171** (0.07661)
FEED (kg/m²)	β_2	0.00876 (0.00638)	0.0534* (0.0166)
LABO (man days/m²)	β_3	0.0113 (0.00638)	0.0353 (0.0207)
POSI (m²)	β_4	0.7554* (0.0772)	0.720* (0.0779)

Inefficiency effects model			
Constant	δ_0		0.141*** (0.0713)
AROADS (dummy)	δ_1		0.0127 (0.0133)
COSTPF (₦)	δ_2		-0.00216 (0.00344)
COSTSF(₦)	δ_3		-0.00175 (0.00263)
EDUCAT (yrs)	δ_4		-0.0506 (0.541)
EXPERI (yrs)	δ_5		-0.0127 (0.0263)
ACONS (dummy)	δ_6		-0.0631* (0.0182)
CREDIT (₦)	δ_7		-0.00207 (0.0031)
COSTIN (₦)	δ_8		-0.00315 (0.00252)
AVLMKT (dummy)	δ_9		0.00908 (0.00943)
Variance parameters			
Sigma-squared	σ^2	9181.350* (55.470)	0.00222* (0.000286)
Gamma	γ	0.0258 (0.133)	0.000311** (0.000137)
Log Likelihood	LLF	-1038.077	283.723
LR test of the one sided error	LR		30.612

*,** and *** indicate that the parameter is significant at the 1, 5 and 10%, respectively, figures in parenthesis are error values

Table 7: Statistics for Test of Hypothesis

Null Hypotheses	LLF	LR Statistics	Df	Critical Value (α=0.05)	Decision
H0: $\gamma = \delta_0 = \delta_1 = \delta_2 ... = \delta_9 = 0$	H1 = 268.417 H0 = 283.723	30.612*	9	16.274	Reject H0

* An asterisk on the value of the test statistic indicates that it exceeds the 95th percentile for the corresponding x^2-distribution and so the null hypothesis is rejected on the Kodde and Palm Table

4.3. Technical Efficiency of Catfish Producers in the Study Area

To investigate the presence of technical inefficiency on the relationship between business environment and catfish production, the study discussed the estimated gamma (γ) (see Table 6). From the analysis, the study obtained 0.000311 of γ, which was found to be significant at 5%. This shows that inefficiency effects are significant amongst the catfish farmers.

This is not a surprising result for an agribusiness production enterprise where one would normally expect business environment data noise to play a role. Confirming this observation further is the result of the technical efficiency estimated for Benue State (see Table 8). The estimated technical efficiency ranged between 0.813 and 0.989 with an average of 0.967. This value, however, suggests that approximately 4% of the catfish output for an average farm, from the study, is forgone due to inefficiency in the production process. Nonetheless, this finding is slightly higher than the technical efficiency obtained in Ojo, Fagbenro and Fapohunda (2006) with an average Technical Efficiency of 0.83 and Kareem, Dipeolu, Aromolaran and Akegbejo (2008) with an average Technical Efficiency of 0.88. However, Figure 1 depicts a graphical representation of the technical efficiency estimates for catfish production in the study area.

Table 8: Technical Efficiency Estimates for Catfish Producers in Benue State

1	0.92648204E+00	46	0.87880669E+00	91	0.98397899E+00	136	0.98929520E+00
2	0.91602573E+00	47	0.92548191E+00	92	0.92681085E+00	137	0.91996092E+00
3	0.89131679E+00	48	0.97340114E+00	93	0.97249341E+00	138	0.92655921E+00
4	0.95052696E+00	49	0.81318722E+00	94	0.98148614E+00	139	0.88915655E+00
5	0.91645401E+00	50	0.81850040E+00	95	0.94484814E+00	140	0.832091382+00
6	0.92784940E+00	51	0.90598802E+00	96	0.92761467E+00	141	0.92400321E+00
7	0.98875982E+00	52	0.91376806E+00	97	0.90487632E+00	142	0.91278801E+00
8	0.98512380E+00	53	0.94854263E+00	98	0.86973537E+00	143	0.81293891E+00
9	0.92972160E+00	54	0.88495856E+00	99	0.98812233E+00	144	0.87970577E+00
10	0.82672056E+00	55	0.97472764E+00	100	0.96081325E+00	145	0.91731893E+00
11	0.97912678E+00	56	0.92679193E+00	101	0.98942171E+00	146	0.97723525E+00
12	0.93359073E+00	57	0.934106542+00	102	0.95132944E+00	147	0.97635586E+00
13	0.87994489E+00	58	0.94247987E+00	103	0.97085839E+00	148	0.91858409E+00
14	0.92734716E+00	59	0.98943446E+00	104	0.891130742+00	149	0.97851537E+00
15	0.93611689E+00	60	0.890219663+00	105	0.97629421E+00	150	0.91996092E+00

16	0.98220030E+00	61	0.98254797E+00	106	0.96577350E+00	151	0.92300116E+00
17	0.98924843E+00	62	0.94941607E+00	107	0.98709024E+00	152	0.85988108E+00
18	0.98551284E+00	63	0.98574988E+00	108	0.98346120E+00	153	0.88895996E+00
19	0.81149281E+00	64	0.81622934E+00	109	0.88586782E+00	154	0.95262947E+00
20	0.81293891E+00	65	0.81243721E+00	110	0.98238124E+00	155	0.90443146E+00
21	0.98704410E+00	66	0.982987892+00	111	0.98566882E+00	156	0.95469251E+00
22	0.93010410E+00	67	0.98339913E+00	112	0.97476488E+00	157	0.88851382E+00
23	0.96486027E+00	68	0.98806935E+00	113	0.93610263E+00	158	0.92921717E+00
24	0.93977426E+00	69	0.92463742E+00	114	0.88677337E+00	159	0.97121851E+00
25	0.91352332E+00	70	0.81147948E+00	115	0.91455005E+00	160	0.89139526E+00
26	0.90468998E+00	71	0.98910694E+00	116	0.83516070E+00	161	0.90691633E+00
27	0.81742392E+00	72	0.97609577E+00	117	0.94676211E+00	162	0.81172049E+00
28	0.96976663E+00	73	0.98231274E+00	118	0.98491226E+00	163	0.90691570E+00
29	0.87715439E+00	74	0.98051103E+00	119	0.83750660E+00	164	0.891106542+00
30	0.93615741E+00	75	0.82439022E+00	120	0.92220058E+00	165	0.92596647E+00
31	0.98120168E+00	76	0.93165659E+00	121	0.92163311E+00	166	0.94631067E+00
32	0.93056321E+00	77	0.92464232E+00	122	0.88291837E+00	167	0.90790117E+00
33	0.91490602E+00	78	0.87334295E+00	123	0.91242436E+00	168	0.87595645E+00
34	0.87986661E+00	79	0.98371884E+00	124	0.97204756E+00	169	0.98434927E+00
35	0.92598825E+00	80	0.97449954E+00	125	0.92333371E+00	170	0.87570003E+00
36	0.890107252+00	81	0.91173654E+00	126	0.954106542+00	171	0.90375123E+00
37	0.94361847E+00	82	0.82690842E+00	127	0.83299417E+00	172	0.97666944E+00
38	0.98632155E+00	83	0.92465026E+00	128	0.98862784E+00	173	0.84575030E+00
39	0.82531408E+00	84	0.82894001E+00	129	0.95983489E+00	174	0.98033973E+00
40	0.93516070E+00	85	0.91517594E+00	130	0.84364226E+00		
41	0.93810132E+00	86	0.95118888E+00	131	0.98573548E+00		
42	0.98940229E+00	87	0.91990129E+00	132	0.92984238E+00		

43	0.95520473E+00	88	0.82740195E+00	133	0.88593417E+00
44	0.93048829E+00	89	0.84979308E+00	134	0.98339536E+00
45	0.93043197E+00	90	0.891317817+00	135	0.19811111E+00

mean efficiency = 0.96655455E+00

The presence of technical inefficiency on the relationship between catfish business environment and resource use for Zones A, B, C and pooled data in estimated gamma (γ) usage is indicated in Table 9. The analysis obtained is as follows: 0.999 for Zone A, 0.0454 for Zone B, 0.0499 fro Zone C and 0.000311 for pooled data. Only the γ coefficient for the pooled data was significant. This indicates that inefficiency effects are not significant amongst the catfish farms in Zones A, B and C alone except for pooled data. However, if we were to test for hypotheses in Zones A, B and C, our decision would be to accept the null hypotheses. The technical efficiency is: 1.0007 for Zone A, 1.0281 for Zone B, 1.1881 for Zone C and 0.9797 for pooled data. This information tells us that Zones A, B and C are operating in stage 1, while the pooled data is operating in stage 2 of the production function.

4.3.1. Features of the most efficient catfish farmer in the study area

The most efficient catfish farmer for this study had a Technical Efficiency of 0.989 which indicates that only 1% of the catfish output is forgone due to inefficiency from business environment in the production process. The farmer had access to good roads from and to his production unit and markets. The cost of energy was reduced by the use of solar cells. The cost of storage facilities for water was less because the farmer had dug a well within his catfish production site. The farmer spent more years in acquiring formal education than most of the farmers interviewed. He also acquired appreciable years of experience in catfish production. He collaborated with model catfish farmers over the years. He obtained credit from a corporative society he belongs to. This farmer was able to carry out strategies that reduced the effect of threats from the business environment. Control of the environment made it possible for this most efficient farmer to have immediate control over his inputs. Procuring fish processing facilities like solar due to epileptic electricity supply helped the most efficient catfish farmer to dry (preserve) excess catfish output that were not sold immediately. This was a strategy used by the most efficient catfish producer to curb the perturbation arising from energy or electricity supply issue in the study area.

Table 9: Estimated Cobb–Douglas Production Frontier Results Across Zones

		ZONE A	ZONE B	ZONE C	POOLED DATA
		(n=33)	**(n=105)**	**(n=36)**	**(n=174)**
Variable	parameters				

Frontier Prod. Function					
Constant	β_0	-0.164 (0.486)	0.361 (0.282)	-0.0691 (0.873)	0.391** (0.177)
FING (kg/m^2)	β_1	-0.0833 (0.154)	0.233** (0.113)	0.241 (0.846)	0.171** (0.07661)
FEED (kg/m^2)	β_2	0.405* (0.0819)	0.0580* (0.0195)	0.0811 (0.713)	0.0534* (0.0166)
LABO (man days/m^2)	β_3	0.109 (0.109)	0.0181 (0.0264)	0.147 (0.789)	0.0353 (0.0207)
POSI (m^2)	β_4	0.570* (0.180)	0.719* (0.118)	0.719 (0.775)	0.720* (0.0779)
Inefficiency effects model					
Constant	δ_0	0.115 (0.137)	-0.0593 (0.233)	-0.0000333 (0.932)	0.141*** (0.0713)
AROADS (dummy)	δ_1	0.0167 (0.0151)	0.00310 (0.0195)	-0.000164 (0.909)	0.0127 (0.0133)
COSTPF (₦)	δ_2	-0.00344 (0.00399)	0.00198** (0.00976)	-0.000245 (0.931)	-0.00216 (0.00344)
COSTSF(₦)	δ_3	-0.00214 (0.00444)	-0.020 (0.00969)	-0.000414 (0.973)	-0.00175 (0.00263)
EDUCAT (yrs)	δ_4	0.00651 (0.0780)	0.0843 (0.169)	-0.000652 (0.863)	-0.0506 (0.541)
EXPERI (yrs)	δ_5	0.01687 (0.0284)	0.0111 (0.0395)	-0.000699 (0.852)	-0.0127 (0.0263)
ACONS (dummy)	δ_6	0.0286 (0.0301)	-0.0331 (0.0829)	-0.00308 (0.988)	-0.0631* (0.0182)
CREDIT (₦)	δ_7	-0.00477 (0.00492)	-0.00723 (0.0146)	0.00248 (0.988)	-0.00207 (0.0031)
COSTIN (₦)	δ_8	-0.0194** (0.00759)	-00178 (0.00769)	-0.0150 (0.725)	-0.00315 (0.00252)
AVLMKT (dummy)	δ_9	0.0407** (0.0149)	-0.0110 (0.0524)	-0.000808 (0.849)	0.00908 (0.00943)
Variance parameters					
Sigma-squared	σ^2	0.000860 (0.000214)	0.00280 (0.000565)	0.00244 (0.257)	0.00222* (0.000286)

Gamma	γ	0.999 (4.676)	0.0454 (0.592)	0.0499 (0.946)	0.000311** (0.000137)
Log Likelihood	LLF	69.721	161.093	65.367	282.634
LR test of the one sided error	LR	11.702	5.081	8.549	28.434

*,** and *** indicate that the parameter is significant at the 1, 5 and 10%, respectively, figures in parenthesis are error values

4.4. Constraints of Catfish Farming in the Study Area

Catfish farmers encountered many problems during the production process. These challenges include: high cost of feeds; Lack of capital; high cost of labor; scarcity of quality fingerlings; lack of modern technologies; lack of land; poaching by people, birds, reptiles and snakes; inadequate water supply; cost of alternative power supply; mortality of fish; poor storage facilities; inaccessibility to good roads; and collaboration with model catfish farmers.

In this part of the world, electricity is unstable and will result to spoilage of the excess catfish if the farmer tries to store them in the freezer. Installing storage facilities for water due to unavailability of water supply is another strategy by the catfish manager to reduce the negative influence caused by the water supply issue in the physical environment of business. Analysis of the problems was done by means of a five point Likert Scale (strongly disagree=1, disagree=2, moderately=3, agree=4, strongly agree=5) that produced a critical mean of 3.39. Results of the analysis are shown in Table 10.

High cost of feeds was indicated by the respondents as the most serious constraint to catfish production with mean scale of 3.85. The importation of most commercial feeds into the country and problems associated with importation and distribution could be the main reasons for high cost of feeds. These commercial feeds possess floating and high protein qualities and are therefore preferred by fish farmers. This result is in consonance with the records of Ocmer (2006) and Ugwumba and Chukwuji (2010). Ugwumba and Nnabuife (2008) also identified high cost of feed as very serious draw back to profits realizable from catfish farming. The second serious problem was the problem of lack of capital (4.64). Catfish farming is capital intensive and thus requires big capital investment for reasonable profit to be made. Small-scale farmers were indicated by Kudi *et al.* (2006) to lead the problems encountered by fish farmers in Kaduna State, Nigeria.

High cost of labor had a mean score of 4.58 in order to become the third serious problem encountered by the respondents. Scarcity of quality fingerlings with a mean score of 3.95 posed as the fourth challenge to catfish farmers. This was due to inadequate local supplies of catfish fingerlings attributed to abandoned hatcheries and few private ones in the study area. Farmers were therefore compelled to import most of their seeds from neighboring States. A similar reason was given by Adeogu *et al.* (2007) to have affected fish farming in Lagos State negatively. Other constraints not asterisked which were below the critical mean of 3.80, that is

– lack of modern technologies (3.60); lack of land (3.54); poaching by people, birds, reptiles and snakes (3.52); inadequate water supply (2.87); cost of alternative power supply (2.73); mortality of fish (2.71); poor storage facilities (2.65); inaccessibility to good roads (2.47) were perceived as moderately serious problem. However, less collaboration with model catfish farmers (1.88) posed no problem to catfish farming in the study area.

Table 10: Challenges of Catfish Production in the Study Area

Challenges	Mean Score	Rank
High cost of feeds	4.89*	1st
Lack of capital	4.64*	2nd
High cost of labor	4.58*	3rd
Scarcity of quality fingerlings	3.95*	4th
Lack of modern technologies	3.60	5th
Lack of land	3.54	6th
by people, birds, reptiles and snakes	3.52	7th
Inadequate water supply	2.87	8th
Cost of alternative power supply	2.73	9th
Mortality of fish	2.71	10th
Poor storage facilities	2.65	11th
Inaccessibility to good roads	2.47	12th
Collaboration with model catfish farmers	1.88	13th

Source: Field Study, 2014
Note: overall critical mean of the 13 items on the table is 3.39.

The theory of change in turbulent times established that managers should reflect organizational competencies to achieve new and innovative forms of competitive advantage despite constraints of path dependencies and previous market positions (Arthur, 1994; Gruca and Nath, 1994; Leonard-Barton, 1992). It also emphasize that, dynamic capabilities result from complicated organizational and strategic routines (Zollo and Winter, 2002) through which managers reconfigure and renew a firm's resource base to generate economically valuecreating strategies (Foss, 1996; Pisano, 1994). The strategy used by respondents who score critical mean value of 3.39 and above, regarding the 13 items in Table 10, is to update themselves regularly on the latest catfish production techniques. The negative coefficient exhibited by variable item in the general model, implies that increase in credit obtained from financial institutions, would lead to a decrease in the level of technical efficiency in the general model. This implies that credit obtained from financial institutions may be too costly. This is because the catfish manager tries to cushion effects from perturbations exhibited by other environment variable items such as procuring fish processing facilities and cost of procuring water storage facilities.

5. Conclusion and Recommendations

5.1. Conclusion

The study found out that one of the nine business environment variables included in the general model, accessibility to consultants/veterinary services, exerted significant influence on the catfish farm inefficiency level in Benue State. However, the variable exhibited negative sign implying that increased access to consultants lowers technical efficiency. This is contrary to *a priori* expectations that increased access to consultants/veterinary services leads to higher productivity. Thus, the study came up with the conclusion that, business environment (i.e. physical, social and institutional) factors do have effect on catfish production in Benue State, Nigeria.

5.2 Recommendations

Based on the findings of this study, the following recommendations are appropriate:

i. In order to have effective control over the inputs resources within the catfish business environment, efforts should be made by academics and managers to identify other environmental factors such as government/political/legal, economic, natural, suppliers, etc, that could pose serious threats.

ii. Catfish farm managers could provide alternative sources of water supply like the digging of boreholes or wells to reduce the cost of buying water.

iii. Improvement in the years of experience in catfish production business could be achieved if catfish managers attend trainings or demonstration farms at least once every year.

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