British Journal of Arts and Social Sciences
ISSN: 2046-9578, Vol.4 No.2 (2012)

http://www.bjournal.co.uk/BJASS.aspx

Determinants of Technical Efficiency Differentials among Concrete and Earthen Pond Operators in Oyo State-Nigeria

Ajao, A.O
Agricultural economics department
Ladoke akintola university of technology
Ogbomoso
oaajao57@lautech.edu.ng

Abstract:

The study analysed the technical efficiency of earthen and concrete ponds in Oyo State from a sample of 80 earthen fish farmers and 120 concrete fish farmers selected from two Agricultural zones in Oyo state given a grand total of 200 fish farmers using Data Envelopment Analysis (DEA) approach to analyse the technical efficiency of earthen and concrete ponds. The average overall technical efficiency estimates obtained under the CRS and VRS specifications for earthen pond fish farmers are respectively 0.91 and 0.94. Under the CRS, sex and education with t-ratio of -1.96 and -4.38 while with VRS assumption, sex and educational were equally significant. For concrete ponds two variables statistically determined the technical efficiency under the CRS, are occupation and land acquisition. The study concluded that substantial inefficiency in earthen and concrete ponds occurred in the area. The study concluded that substantial inefficiency in earthen and concrete ponds occurred in the area.

Key words: Data envelopment analysis; earthen pond; return to scale; efficiency

Introduction:

Fish farming or aquaculture has been in practice since the ancient civilizations of Egypt and China. Although, fish farming had existed in Africa (Egypt) since 2000BC, it started in Nigeria in 1942 as a hobby by expatriate fisheries officers. Conventional aquaculture began in Nigeria about 1951 with the establishment of the panyam some 80km south east of Jos in the Middle Belt region of the country and present State Capital of Plateau State. The farm served as the first training and extension center for fish farming in the country (Donald, 2004). At present, most fish farms in Nigeria are fresh water based and cultured species include cichlids of the genera *(Oreochromis and Sarotherodon)* and cat fishes (Clarias, Heterobranchus and their hybrids). Current production from aquaculture is about 26,000 metric tones which is less than 0.01% of the national capacity. Over the years, several governments and individual fish farm has been set up. Some have been successful, while others have failed due to the shortage of inputs (Fingerlings and feed), lack of knowledge resulting in poor management, inadequate funding, theft and direct involvement of the government in production which may be attributed to unavailability of basic principles guiding a profitable aquaculture venture and these major constraints identified as being responsible for the low production from aquaculture. (Anetekhai et al.,2004).

Fishery in Nigeria is mainly done by artisan sector. The coastal and brackish water constitute the major areas of production followed by inland rivers and lakes. (Nigeria's Agricultural sector, 2001). A fishery is an area with an associated fish or aquatic population which is harvested for its value (commercial, recreational, subsistence). It can be saltwater or freshwater, wild or farmed. Examples are the salmon fishery of Alaska, the cod fishery of the Lofoten Islands or the tuna fishery of the Eastern Pacific. Most fisheries are marine, rather than freshwater; most marine fisheries are based near the coast. This is not only because harvesting from relatively shallow waters is easier than in the open ocean, but also because fish are much more abundant near the coastal shelf, due to coastal upwelling and the abundance of nutrients available there. However, productive wild fisheries also exist in open oceans, particularly by seamounts, and inland in lakes and rivers. Most fisheries are wild fisheries, but increasingly fisheries are farmed. Farming can occur in coastal areas, such as with oyster farms, but more typically occur inland, in lakes, ponds, tanks and other enclosures (FAO, 1992).

There are fisheries worldwide for fish, mollusks and crustaceans, and by extension, aquatic plants such as kelp. However, a very small number of species support the majority of the world's fisheries. Some of these species are herring, cod, anchovy, tuna, flounder, mullet, squid, shrimp, salmon, crab, lobster, oyster and scallops. All except these last four provided a worldwide catch of well over a million tones in 1999, with herring and sardines together providing a harvest of over 22 million metric tons in 1999. Many other species as well are harvested in smaller numbers (Hatch and Tai, 1997)

Short supply and increase in human population have the combined effect of raising cost of animal protein to a level beyond the reach of the low-income groups. This situation has given rise to considerate increase in demand for fish to supplement animal protein (Ayodele and Fregene, 2003). It is a well-known fact that animal protein is seriously inadequate in the daily diet of many people in Nigeria. This protein deficiency causes illness and death. It also reduces immunity to disease and can lead to poor growth. Therefore it is necessary to increase protein production by introducing new sources of protein and intensification of existing means of production. However, from Okpanefe (1998), Nigeria's fish consumption in year 2000 was projected at 2.035 million tones with a projected per capita consumption of 14.49kg for the projected population of over 140 million people. According to Adeniyi (2002), the cause of inadequate intake of protein is linked with or as a result of the inability of the fish farming industry to expand fast enough to supply the required quantities of fish. Despite all developmental programmes on food accessibility and availability carried out by the Nigerian government, hunger and malnutrition still exists in most part of the country. In a meeting of the African Regional Nutrition strategy in 1993, Nigeria was included as one of the countries having the lowest daily per capita supplies of between 70-90 percent of nutrition requirements. In view of this, It important to consider the comparative efficiency of earthen and concrete fish pond in relationship to productions and to suggest the measure that could promote improvements in both in order to foster more fish availability for consumption of the rapidly increasing Nigerian populace.

Data Envelopment Analysis (DEA)

DEA is a linear programming based technique for measuring the relative performance of Decision Making Units (DMUs) where the presence of multiple inputs and outputs makes comparisons difficult. DEA is a relatively new approach for evaluating the performance of set of decision-making units (DMUs), which convert multiple outputs. The definition of a DMUs is generic and in recent years has been a great variety of applications of DEA in evaluating the performances of many different kinds engaged in many different activities in many countries.DEA provides a means of calculating apparent efficiency levels within a group of DMUs. The efficiency of a DMU is calculated relative to the group's observed best practice. When there are multiple inputs and multiple outputs, a common measure for relative efficiency is

$$\text{Efficiency} = \frac{\text{Weighted Sum of outputs}}{\text{Weighted Sum of inputs}}$$

Each DMU picks weights such that it maximize its own efficiency subject to constraints that ensure: (1) no unit can have an efficiency score greater than 1 and (2) every weight must be strictly greater than 0. Let us assume there are n DMUs, each DMU has t outputs and in inputs. Let us take DMU, as an example, the linearised output oriented DEA model is:

Maximise $h = \sum^{t} u_r y_{r_1}$

Subject to: $\sum^{m} v_i^{r=1} x_{i_1} = 1$

$$\sum_{r=1}^{i_t=1} u_r y_{r_j} - \sum_{i=1}^{m} v_i x_{i_j} \leq 0 \quad j = 1,2......n$$

$$u_r \geq \varepsilon, r = 1,2,...t$$

$$v_i \geq \varepsilon, i = 1,2,...m$$

Where U_r is the weight of output r v_i is the weight of input i, y_{rj} is the amount of output r of DMU_j (j =1, ….n), X_{ij} is the amount of input i DMU_j (j = 1, ….n) and ε is a small positive number. The result of the DEA is the determination of the hyperplanes that define an envelope surface or pareto frontier. DMUs that lie on the surface determine the envelope and are deemed efficient, whilst those that do not are deemed inefficient. A complete DEA solves n linear programs, one for each DMU. DEA has been applied to a variety of industrial and service landscapes banks, airports, hotels, hospitals. The aim here is to determine corporate or branch efficiency compared to a competitor or ideal. Often the main goal of measuring efficiency is to determine which companies to do business with Weber and Desal highlight DEA's ability to distinguish between material suppliers and then use this distinction as a bargaining tools for less efficient suppliers DEA is so often applied to the "bottom line" that is use in areas outside strict profitability. These DEA applications have various forms of evaluating the performance of entities such as hospitals, Air force wings, universities cities, court, firms and others including the performance of countries (Cooper, et al., 1999) As pointed out by Cooper, Seiford and Zhu (1999), DEA has been used to supply new insights into activities (and entities) previously been evaluated by other methods, for instance, benchmarking practices with DEA has identified numerous inefficiencies in some of the most profitable firms, firms served as benchmarks by reference profitability has provided a vehicle for identifying better benchmarks for many applied studies. DEA utilizes techniques such as mathematical programming, which can handle numbers of variables and relations (constraints) and this relaxes the requirements that are often encountered when one is limited to choosing only few inputs and outputs because the techniques employed will otherwise encounter difficulties. DEA provides dual collabaration between analyst and decision makers, which extend from collaboration in choice of the inputs and outputs to be used and includes choosing the type of "what-if" question to be addressed, such collaborations extend to bench marking of "what-if" behaviour of competitors and include identifying (new) competitors that may emerge for consideration in some of the scenarios that might be generated (Zhu and Sarkis, 2004),

Additional advantage of DEA where also noted in terms of (a) its ability to identify sources and amount of inefficiency in each input and each output for each entity (hospital, firm, store etc) and (b) its ability to identify the benchmark members of the efficient set used to effect these sources (and) amount of inefficiency. Data envelopment analysis is a non-parametric mathematical programming analysis model may be classified into two groups oriented model such as those of Charnels *et al.,* (1978) and additive model, such as that of Charnels (1985). An appropriate method for anlaysing technical efficiency is the Data Envelopment Aanalysis method (Banker et al., 1984). Banker states that "Using DEA the weighted input firms have considerable flexibility in determining combinations of inputs to produce different combinations of outputs according to their preferred weights". Therefore more than one firm can be technically efficient only a small percentage of agricultural frontier applications have used the DEA approach for frontier estimation. Given the popularity of mathematical programming method on other of agricultural economics research during the 1960s and 1970s. However, DEA has a very large percentage in other professions especially in the management output such as banking, health and telecommunications and electricity distribution (Cooper *et al*., 1999). The envelopment solution to a DEA mind produces two useful by-products as follows one, it supplies information on the peers and two, it supplies information on the target of each inefficient firms in the sample. The peers of inefficient firms are to be model firms. They are efficient firms, which have similar input mixes with the inefficient firms. The targets are coordinates of the efficient projected point (for the inefficient firm) and now provide the input and output qualities that the inefficient firm should be able to achieve, if it were to operate on efficient frontier (Coelli, 1997) for instance, efficiency consideration which are central to the DEA evaluations of interest are introduced by using the familiar and every simple ratio definition of output divided by input. This ratio formulation is then extended to multiple outputs and multiple inputs in a manner that makes contact with more complex formulation. (Cooper *et al.,* 1999).

Literature review

Kareem *et al*., (2008) analyzed the technical, allocative and economic efficiency of different pond systems in Ogun state, Nigeria. The study investigated the costs and returns analysis of the respondents and the stochastic frontiers production analysis was applied to estimate the technical, allocative and economic efficiency. The results of the returns to Naira invested shows that earthen pond system yielded than concrete pond system. The results of economic, allocative and technical efficiency revealed that earthen pond system is higher than concrete pond system. Stochastic frontier production models showed that pond area, quantity of lime used, and number of labour used were found to be the significant factors that contributed to the technical efficiency of concrete pond system. While pond, quantity of feed and labour are the significant factors in earthen pond system. The result therefore concluded that only years of experience is the significant factors in concrete pond system in the inefficiency sources model. On the basis of findings, the study suggested that government of Nigeria should provide a conducive environment for the establishment of both concrete & earthen pond system, encourage more citizenry, mostly youth to set up both pond systems in a bid to alleviate poverty status and un-employment rate in the state and the country at large.

Sharma and Leung (1998) examined the technical efficiency of carp production in Nepal. In Nepal, productivity in aquaculture is much lower compared to other countries in the region which suggests that there is potential for increased fish production through technological progress and improvement in farm level technical efficiency. However, no formal analysis has yet been conducted to assess the productive performance of Nepales aquaculture and its potential for future improvement. Against this background, it examines the technical efficiency and its determinants for a sample of fish pond farms from the Tarai region of the country using a stochastic production frontier involving a model for technical efficiency of intensive farms being more efficient that extensive farms. The adoption of regular fish, water, and feed management activities has a strong positive effect on technical efficiency.

Adeokun *et al.,* (2006) investigated children's involvement in fish production in waterside local Government Area, Ogun State, Nigeria. Multi-stage technique was used. The findings of the research showed that male children dominated fish catching and net making and mending while the female children were mainly involved in processing. All other activities in which the children were involved were water fetching, fish marketing, fish processing and fish storage among others gave no significant difference on gender basis. Based on the findings, it was recommended that government and non-governmental agencies should come up with special programmes and incentives for revering fishing village's that will ensure effective integration of children into national programmes for food itself sufficiency and poverty alleviation at household and national levels.

Anetekhai *et al.,* (2004) conducted a study on aquaculture development in Nigeria. The current production from aquaculture is about 26,000 metric tones which is less than 0.01% of the national capacity. The major constraints identified as being responsible for the low production from aquaculture are shortage of inputs (fingerlings and feed), lack of knowledge resulting in poor management, inadequate funding, theft and direct involvement of the government in production. The study recommends some measures to be taken for the development of aquaculture in Nigeria particularly the creation of a ministry of fisheries to co-ordinate all activities in the sector and provides an enabling environment for aquaculture.

Sampling Procedure and Sample Size

Multi-stage sampling procedure was used. Firstly, two agricultural zones were selected from all the agricultural zones in Oyo-State. These were Ogbomoso and Ibadan/Ibarapa zones. Ogbomoso Agricultural Zone and Ibadan - Ibarapa agricultural zone was selected due to the present of many aquaculture farmers in the area. Secondly, all Local Government Areas were sampled from Ogbomoso zone and Ibadan/Ibarapa zone. Thirdly, registered fish farmers were chosen and fourthly from these registered fish farmers, 80 earthen fish farmers and 120 concrete fish farmers were randomly selected. In all, 200 fish farmers were selected.

The data that was used in this study is essentially from primary sources namely the fish-farmers in the study area. Structured questionnaires were used to collect information needed from the sample of fish farmers. The structured questionnaires were used to draw out information on variables such as pond data, land data, stocking or pond number source of stocking material, feed, labour data, harvesting time data, marketing, loan inventory of asset data cost etc. These variables were identified within the framework of the study objectives. For the purpose of this study the major variables that were considered are the following output and input.

Y = Fish output (kilogram)

X_1 represented the quantity of fingerlings (kg).
X_2 represented fish pond (m^2)
X_3 represented the quantity of feed that was used on the farm (kg of dry matter weight)
X_4 represented the quantity of supplementary feed like: (waste of animal by product) used to feed the animal in kilogram
X_5 represented the fertilizer used to culture the fish (kilogram)
X_6 represented labour. (man-day)

Analytical Technique

Multi-stage DEA was used to analysed the data obtained. In Multi-stage DEA, the outputs from one process can be the inputs for the next. However, it is sometimes possible to merely "line up" outputs with wherever they occur again as inputs, not necessarily in the next consecutive node. Unique features of multi-stage DEA make it useful. That is, data flow from stage to stage in the model just as work parts. There is evidence that DEA conducted in multiple stages yields more reliable data and also has been configured to place more emphasis on inputs which are within management control.

Determinants of fish production efficiency

After calculation of the efficiency measures, the next step is to identify the determinants of inefficiency, sometimes commonly done by estimating a second stage relationship between the efficiency measures and suspected correlates of inefficiency (Barnes, 2006). Since the efficiency parameters vary between 0-1, they are censored variable and thus a Tobit model needs to be used.

$$\theta^k = \beta_0 + \beta_1 Z_1 + \beta_2 Z_2 + -- \beta jzj + e$$
$$= Z\beta + e$$
$$\theta^k = \beta^{k*} \; if \; 0 < \theta^k < 1$$
$$= 0 \; if \; \theta^k < 0$$
$$= 1 \; if \; \theta^k > 1$$

Where θ^f is the DEA efficiency index as dependent variable and Z is a vector of independent variables related to attributes of the farmers/farm within the sample. The independent variables included in the model are
Z_1 = Sex (Male =1 Female = 0)
Z_2 = Family Size (actual number)
Z_3, = Education *(* Year of schooling)
Z_4 = Occupation (Full time fish farming =1, Part time fish farming = 0
Z_5 =Social organization (1 if fish farmer is a member, 0 if otherwise)
Z_6 = Land acquisition – (Purchase = 1, 0 if otherwise)

Results and discussion

Overall efficiency estimates of earthen pond farmers

The frequency distribution of the earthen pond fish farmers technical efficiency under the constant Return to Scale and the Variable Return to Scale (CRS and VRS) efficiency estimates is given in table 1. The average overall technical efficiencies are 0.91 and 0.94 for CRS and VRS respectively. Substantial inefficiencies occurred in the fish pond farming of the sampled earthen pond fish farmers in the study area. Under this current circumstances, about 5% and 13.8% of ponds were identified as fully technically efficient under the CRS and VRS specification respectively. The observed difference between the CRS and VRS measures further indicated that some of the earthen pond fish farmers did not operate at an efficient scale and improvement in the overall efficiencies could be achieved if the farmers adjusted their scales of operation. Under the CRS, the group with the highest frequency of technical efficiency is 0.90-0.94 amounting to 50% of the sampled earthen pond fish farmers. This was followed by group 0.85-0.89 with a percentage of 25% of the total respondents under earthen pond. Under the VRS, the group with the highest frequency of technical efficiency is also 0.90-0.94 amounting to 46.3% of the sampled earthen pond fish farmers, followed by the group 0.95-0.99 with 25%. The lowest technical efficiency scores fall within the 0.75-0.84 group under VRS specification. The mean of the distribution under CRS and VRS are 0.91 and0.94, the minimum are 0.812 and 0.83, maximum 1.00 and standard deviation are 0.044 and 0.0.041respectively.

Table 1: Overall efficiency of earthen pond farmers.

	Constant return to scale		**Variable return to scale**	
Technical Efficiency	**Frequency**	**Percentage**	**Frequency**	**Percentage**
0.80-0.84	06	7.5	01	1.3
0.85-0.89	20	25.0	11	13.8
0.90-0.94	40	50.0	37	46.3
0.95-0.99	10	12.5	20	25
1.00	04	5	11	13.8
Total	**80**	**100**	**80**	**100**
Mean	0.913898		0.941013	
Minimum	0.812		0.83	
Maximum	1.0		1.0	
Standard dev.	0.043696		0.040873	

Source: author's computation

Overall efficiency estimates of concrete pond farmers.

Table 2 gives the frequency distribution of the concrete pond CRS and VRS efficiency estimates. The average overall technical efficiency under CRS is 0.93 while the average technical efficiency under the VRS specification is respectively 0.97. This result also reveals that substantial resource use inefficiencies occurred in the fish pond farming of the sampled concrete pond fish farmers in the study area. Under the prevailing condition, the percentage of ponds that achieved full efficiency technically under the CRS is 5%, under the VRS, those that are technically efficiency is 39.2% respectively. The large difference between the technical efficiency under the CRS and VRS specification justifies further the need for the concrete pond fish farmers to adjust their scale of operation by optimizing the resources available to them at present like the other pond above, it is obvious that the technical efficiency measures under the VRS are higher than those under the CRS. The technical efficiency of 35% between CRS and VRS specifications revealed the weakness in the scale of operation more than the other pond. The result also adduced to the substantial inefficiency of the concrete pond fish farmers in the study area.

Table 2: Overall efficiency of concrete pond farmers.

Constant return to scale			Variable return to scale	
Technical Efficiency	Frequency	Percentage	Frequency	Percentage
0.75-0.79	01	0.8	00	00
0.80-0.84	02	1.7	00	00
0.85-0.89	21	17.5	01	0.8
0.90-0.94	63	52.5	27	22.5
0.95-0.99	27	22.5	45	37.5
1.00	6	5.0	47	39.2
Total	120	100	120	100
Mean	0.931142		0.967117	
Minimum	0.796		0.876	
Maximum	1.0		0.9785	
Standard dev.	0.036918		0.053351	

Source: authors computation

Earthen and concrete ponds scale efficiency

Table 3 shows that the average scale efficiency indices for earthen and concrete ponds are respectively 0.97 and 0.96. Earthen ponds demonstrating the lowest scale inefficiency and concrete pond operating at the highest scale inefficiency. However, the results show that there are substantial scale inefficiencies in both earthen and concrete ponds. This implies that most of the fish ponds should be larger than their present sizes in order to achieve higher production.

Table 3 Summary of earthen and concrete ponds scale efficiency

	Earthen pond		**Concrete pond**	
Efficiency indices	**No of ponds**	**Percentage of ponds**	**No of ponds**	**Percentage of ponds**
0.80-0.84	01	1.3	02	1.7
0.85-0.89	03	3.8	07	5.8
0.90-0.94	13	16.3	31	25.8
0.95-0.99	49	6.1	69	57.5
1.00	14	17.5	11	9.2
Total	**80**	**100**	**120**	**100**
Mean	0.97175		0.959738	
Minimum	0.812		0.872	
Maximum	1		1	
Standard dev.	0.035089		0.035773	

Source: aouthor's computation

Optimal, sub optimal and super optimal output of the earthen and concrete ponds

Earthen and concrete ponds optimal, suboptimal and super optimal output are reported in table 4. In term of economics of scale, 14 ponds were characterized by constant return to scale, 48 ponds had increasing return to scale and 18 ponds was characterized by decreasing return to scale among earthen pond fish farmers. In concrete pond, 11 ponds operated under the constant return to scale. 106 ponds were characterized by increasing return to scale and only 3 ponds was characterized by decreasing return to scale. If all ponds using the same technology, then it would be expected that return to scale would increase for ponds with a relatively low outputs and decreasing return to scale ponds with a relatively high outputs. Constant return to scale would be expected for ponds with output level equals to the mean output. The mean output of the suboptimal scale is larger than the mean output of the optimal as well as super optimal scales for concrete ponds while that of earthen pond the mean outputs of the super-optimal scale are larger than the optimal and sub-optimal scales. The results indicates that the super optimal output levels overlap a substantial portion of the optimal and sub-optimal outputs, while for concrete pond, the sub-optimal output value overlaps that of optimal and super optimal value.

Table 4 Distribution of earthen and concrete ponds optimal suboptimal and super optimal outputs

Earthen pond/scale	No of ponds	Percentage of ponds	Mean Output (kg)
Optimal	14	17.5	2250
Sub-optimal	48	60.0	1430
Super-optimal	18	22.5	2975
Concrete pond/scale	**No of ponds**	**Percentage of ponds**	**Mean Output (kg)**
Optimal	11	9.2	2150
Sub-optimal	106	88.3	3000
Super-optimal	03	2.5	1513

Source: author's computation

Summary of ponds output slack

Table 5 shows the ponds summary of the output slack under the CRS DEA and VRS DEA specifications. Under the constant return to scale, the output slacks for the earthen ponds and concretes ponds was zero for each of them. This result indicates that, given the present scale of operation and the available resources, the fish farmers could not do anything to increase their output levels beyond the present values irrespective of the adjustment in their input levels because of the difficulty of resource fixity. In the case of the VRS specifications, the output for earthen ponds and concrete ponds are 151kg and 275kg respectively. This result indicates the amount by which the output levels could be increase without a corresponding increase in the amount input used.

Table 5: Distribution of ponds output slack

Ponds	CRS	VRS
Earthen ponds	0	151
Concrete ponds	0	275

Source: Source: author's computation

Summary of ponds VRS input slacks

Table 6 gives the summary of the input slacks under the VRS specification. The fingerlings slack is the amount of the excess quantity of the fingerlings used in fish culture. The output levels realized could still have been realized if the quantity of fingerlings used in culturing had been reduced by 2141. 845kg, the slacks for ponds, feed, fertilizer, labour are 4.205m^2, 17.849kg, 3.917kg, 263.575kg respectively. These values correspond to the excess input used in the farming operation.

Table 6: Distribution of VRS input slacks

Input	Slacks
Fingerlings (kg)	2141. 8
Ponds (m^2)	4.2
Feeds (kg)	263.6
Fertilizer (kg)	3.9
Labour (man day)	17.9

Source: author's computation

Summary of pond output target

Table 7 gives the summary of the output targets. The output target refers to the amount of output the decision making units should aims at producing given the available units inputs. For example in concrete ponds, the minimum output target that some of the DMU should aim at producing fell within the range of 8001- 10,000. Only 1 DMU amounting to 0.83% of the total DMU's in the pond is applicable. None of the DMU in earthen pond had such a low output target range. The same maximum output target range is 10,000 above. Only 5% of the concrete pond fish farmers should aim at producing at this level of output.

Table: 7 Distribution of ponds output target

Target	Earthen ponds		Concrete ponds	
	Frequency	%	Frequency	%
< 2000	9	11.3	3	2.5
2001-4000	27	33.8	58	48.3
4001 – 6000	31	38.8	47	39.2
6001 – 8000	7	8.8	5	4.2
8001 -10,000	6	7.5	1	0.8

> 10,000	0	0	6	5.0
Total	**80**	**100**	**120**	**100**

Source: author's computation

Tobit estimate of determinants of CRS technical efficiency for earthen ponds.

Table 8 shows the estimates for the Tobit Regression for earthen ponds under CRS specification. Under the CRS, two variables had significant effects on the technical efficiency of the earthen ponds. These are sex which had a coefficient of -0.0226 and a t-value of -1.96 and significant at 10 percent level. This implies that female fish farmers are more technically efficient than their male counterpart under CRS. Education had a coefficient of -0.0009 and a t-value of -4.38 and significant at 1%.This means that as the level of education of the earthen ponds fish farmers increases by 1%, the technical efficiency is reduced by 0.0009%. The value of sigma is 0.0421 while the log likelihood function has a value of 133.07696.This shows that the model fits the data i.e the explanatory variables were representative sample of the response variables.

Table 8 : Result of CRS tobit analysis for earthen ponds.

Variables	Coefficients	t-values	p-values
Constant	0.9262375	23.12	0.000
Sex	-0.0225707	-1.96	0.054*
Family Size	0.0004546	0.18	0.860
Education	-0.000932	-4.38	0.000***
Occupation	-0.0037677	-1.22	0.225
Organization	0.0002273	0.05	0.958
Land Acquisition	0.006078	1.23	0.224
Sigma	0.421017		
Log Likelihood	133.07696		

Source: author's computation
*, ** and ***, represent significant at 10%, 5%, and 1% .

Tobit Estimate Of Determinants Of CRS Technical Efficiency For concrete Ponds.

Table 9 shows the estimates for the Tobit Regression for concrete ponds under CRS specification. Under the CRS, two variables had significant effects on the technical efficiency of the concrete ponds. These are occupation which had a coefficient of -0.0035535 and a t-value of -1.72 and significant at 10 percent level. This means that for concrete pond under CRS, part time fish farmers are more likely to be technical efficient than the full time fish farmers. Land acquisition had a coefficient of -00577 and a t-value of -1.71 and significant at 10%.This means that those who acquired land through other methods are likely to be efficient than fish farmers who obtained land through purchase. The value of sigma is 0.0358387 whilethe log likelihood function has a value of 219.66484. This shows that the model fits the data i.e the explanatory variables were representative sample of the response variables.

Table 9: Result of CRS tobit analysis for concrete ponds.

Variables	Coefficients	t-values	p-values
Constant	0.949775	35.90	0.000
Sex	-0.0057693	-0.73	0.467
Family Size	0.0003556	0.24	0.813
Education	-0.0000399	-0.10	0.919
Occupation	-0.0035535	-1.72	0.089*
Organization	0.0060451	1.56	0.122
Land Acquisition	-0.0057721	-1.71	0.090*
Sigma	0.0358387		
Log Likelihood	219.66484		

Source: Field survey 2010.
*, ** and ***, represent significant at 10%, 5%, and 1%.

References

Adeniyi, J.P (2002): Fish consumption in Nigeria Implications for fishery development policies. M.Sc. Thesis submitted to Department of Agriculture Economics and Farm Management, University of Ilroin.

Adeokun, O.A., Adereti, F. O. and Akanni, K.A. (2006): "Children Involvement in Fish Production: A Strategy For Poverty Alleviation in Waterside Local Government Area,Ogun State" Research Jounal of Fishery and Hydrobiology, 1(1): 10-13

Anetekhai, M. A.,Akin-oriola, G.A, Aderinola and Akintola S.L.,(2004) "Steps Ahead for Aquaculture Development in Sub-Sahara Africa-the case of Nigeria. Faculty of Science Fishries, Lagos state University, Apapa-P.M.B 1087, Lagos, Nigeria.

Banker, R.D. Charnes, A. and W.W. Cooper (1984) "Some Models for Estimating Technical and scale inefficiencies in Data Envelopment Analysis" Management Science, 30, 1078-1092.

Barnes, A. P. 2006. Does multi-functionality affected technical efficiency? A non-parametric analysis of the scotlish dairy industry. Journal of environmental management, 80, 287-294.

Charnes, A. Cooper, W.W. and Rhodes, E. (1978): "Measuring the Efficiency of Decision Making Units". European Journal of Operational Research, 2(6): 429-444.

Cooper, W.W., Seiford, L.M. and Zhuq (1999): Data Envelopment Analysis Model and Interpretation Pp. 1-39; Handbook Envelopment Analysis.

Coelli, T.J (1997): A multistage Methodology for the Solution of Oriented DEA Models, Mimeo, centre for Analysis, University of New England , Armidale

FAO (1992): "The state of food and Agriculture 1992" World and Regional Review Marine Fisheries and the law of the sea a decade of change 158 - 177

Fregene, B.T and I.A Ayodele (2003): Essentials of investment in fish farming. Hope publications, Ibadan, Nigeria Pp. 1-37.

Hatch, U, and C.F. Tai (1997); A Survey of Aquaculture production economics and management. Aquaculture Economics and Management vol. 1: No. (1): Pp. 13-27. http://en.wikipedia.org/wiki/Fishery.

Kareem, R.O, Dipeolu, A.O, Aromolaran, A. B and Akegbejo-Samson.(2008)

"Analysis of Technical Allocative and Economic Efficiency of Different Pond System in Ogun State, Nigeria" African Jounal of Agricultural Research,Vol.3(4),Pp.246-254.

Nigeria Agricultural Sector (2001): Opportunities in Nigeria's Agriculture sector 4th November 2001 Pp. 2-3.

Sharma, K.R and Leung, P. (1998), "Technical efficiency of carp production Nepal: An Application of stochastic Frontier production function Approach". Aquaculture Economics and management vol. 2, Iss 3, Pp. 23-35

Zhu.O. and J. Sarkis (2004): "Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises" Journal of Operations Management, volume 22, No. 3 Pp 265-289.