Nigerian Journal of Fisheries and Aquaculture 5(2):104 – 113 September 2017
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Department of Fisheries, Faculty of Agriculture, University of Maiduguri, Nigeria
Available on line: http://www.unimaid.edu.ng
ISSN-2350-1537

Profit Efficiency of Concrete and Earthen Pond Systems in Kwara State, Nigeria: A path towards Protein Self-Sufficiency in Fish farming

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Received March 22, 2017 Accepted August 24, 2017

ABSTRACT
The study focused on the profit efficiency of concrete and earthen fish ponds in aquaculture enterprises in Kwara State, Nigeria. Primary data were collected with the aid of a structured questionnaire administered through personal interviews. A multi-stage random procedure was used to obtain information from 63 and 87 earthen and concrete fish farmers respectively. Data collected were analyzed using descriptive, budgetary and stochastic profit frontier models. The study revealed that both fish farming systems, households were male headed, of average productive age and have access to productive credit through their formal cooperative organizations. The earthen pond system operators earned total revenue of ₦464, 033 per 1,000 pieces with net fish income of ₦144. 1 per fish sold and concrete pond system operators had total revenue of ₦465, 599 per 1,000 pieces with net fish income of ₦69.2 per fish sold. The result showed a profit margin of 31.04% and 14.86%; gross ratio of 33.80% and 19.66%; return on investment of 1.45 and 1.17 for earthen and concrete pond system respectively. There were statistical significant differences between the average profit efficiency levels of earthen fish ponds (0.747) and concrete ponds (0.793) at the 5 % level of probability. Profit loss was significant among farmers who did not go to school for both systems. In conclusion, aquaculture is a profitable and viable business, regardless of the culture system. Fish farmers should form a formidable social organization to benefit from the economy of bulk purchase of fish input supply, fish farm advisory services, increased access to micro-credit, and access to modern fish pond techniques.

Key words: fish farming, cooperative, profit efficiency, training

INTRODUCTION

The dependence on fisheries by millions of people around the world, coupled with increased consumer demand for aquatic food and the depletion of global fisheries has created an impetus to expand fish production through aquaculture, or fish farming (Adeogun *et al.*, 2014). Thus, the increasing supply of farmed seafood, worldwide per capita fish supply has reached a record high in 2014. World aquaculture production now provides half of all fish for human consumption, and for the first time ever has surpassed the contribution of wild-caught fish (Oladimeji *et al.*, 2015; FAO, 2016). Therefore, fish farming has been viewed as a measure of increasing and improving food security, livelihood diversification and income supplements of families (Ibrahim *et al*., 2014).

Ekwegh (2005) stated that commercial fish farming started in Nigeria over 40 years ago, in order to bridge the significant imbalance between food production and the exponential increase in population growth. Although aquaculture production has increased over the years, the total fish demand in Nigeria based on the 2014 population estimate of 180 million was 3.32 million metric tons where domestic fish production from Aquaculture, Artisanal and Industrial fisheries for 2014 was 1.123 million metric tons

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(FCWC, 2017). A supply, demand gap of about 2.197 metric tons therefore still exists nationally with import making up the shortfall at a cost of about $700 billion (FCWC, 2017). Additionally, fisheries are very much an integral part of Agriculture sector in Nigeria, which maintained a steady contribution of 3.5 to 4% to total GDP in 2008 to 2013. This translates to about 10% of agricultural GDP, which itself contributed between 35 and 40 percent within the same period (Oladimeji *et al.*, 2013; Oladimeji, 2017).

Nigeria, like many other developing countries of the world is faced with the task of meeting the protein demands of its ever-increasing human population. Fish has been acknowledged as an important source of animal protein, contributing significantly to the survival and well-being of a large number of the people in the country. Fish is a cheap source of animal protein and has no religious taboo or any known cultural limitation affecting its consumption unlike pork and beef. Therefore, increasing the aquaculture production is clearly needed to meet this demand in the third millennium, especially as the capture fisheries resources are declining, due to over-fishing, habitat destruction and pollution (Olaoye *et al*., 2014).

Ibrahim *et al.,* (2014) opined that economic consideration in the selection of an appropriate aquaculture production system includes observations of its potential for efficiency, farmer access to operating capital and economic return. Aquaculture is the farming of aquatic organisms and plants in fresh, brackish or salt water. Such farming activities are stocking water with seed (fingerlings), fertilizing the water, feeding the organisms, and maintaining water quality. The earthen pond system is the oldest form of fish farming system in Nigeria. The system involves the development of ponds in land with close proximity to a water body or along the course of a gentle flowing stream or spring or the excavation (creation of a cavity or void) of a marked portion of land where water level is close to the ground surface, whereas the culture of fish in concrete tanks is now a common practice in Nigeria. Concrete ponds are made of both vibrated hollow blocks filled with concrete mix or with re-enforced concrete slabs. It can be of varying sizes and shapes. This production system is common in urban cities, particularly where land is not available or suitable for earthen pond construction.

Efficiency in the use of financial resources in farming is an important factor. This can be expanded by emphasizing the need to market the output in such a way as to maximize returns (Harper, 1999). Consequently, Profit from the system and an adequate return on investment are important considerations. Therefore, this paper focuses on achieving a sustainable fish farming production through estimation of profitability in both earthen and concrete production systems. Specifically, to measure and compare the profit efficiency of both system and provide technical suggestions for enhancing productivity, profitability and sustainability of fish farming practices.

MATERIAL AND METHODS

Study area

This study was conducted in Kwara State in 2015. The State comprises 16 Local Government Areas located between latitudes 7º 45' and 9º 30' N and longitudes 2º, 30' E and 6º 25' E with a land mass covering about 32,500 square km, a total land size of 3,682,500 ha and 247,975 farm families in 2006 with a majority (about 70%) living in rural areas (NPC, 2006; Oladimeji *et al.*, 2014). The annual rainfall ranges from 800 mm to 1500 mm per annum. The State has an estimated population of 2.4 million people (NPC, 2006), projected at 3.2 million in 2016 with farm families of about 315,782 representing 3.2% annual growth rate and an average density of 99 persons km^{-2} (Oladimeji *et al*., 2016).

Sampling procedure and Data collection

Primary data were collected in the 2015 production season through the administration of structured questionnaires and interview schedule to sampled fish farmers. A multi-stage sampling procedure was used to select the representatives of the two groups of fish farmers in the study. The first stage involved the purposive selection of 6 Local Government Areas (LGAs) from 12 LGAs where fish farming is predominantly operated in the State. The second stage involved random selection of 2 registered fish farmers' cooperative societies, each from selected LGAs making 12 cooperatives. Thereafter, fish farmers were filtered into earthen and concrete pond users. Finally, a proportionate (20%) random

sampling results in sixty-three (63) and eighty-seven (87) earthen and concrete fish farmers respectively.

Analytical techniques

The budgetary technique employed is explicitly stated as

$NFI_i = GFI_i - TVC_i - TFC_i$ (1)

$GM_i = GFI_i - TVC_i$ (2)

Where: NFI = Net Farm Income (₦); GFI=Gross Farm Income (₦); TVC = Total Variable Cost ((₦); TFC = Total Fixed Cost (₦) and *i*= 1, 2, 3, ……., 67, or …. 87 for EPS or CPS Farmers. The calculation was based on one thousand (1,000) fish stock per pond per fish farming system to allow for uniformity in calculation. The profitability ratios include the profit margin; gross ratio and rate of return on investment, computed to assess a business ability to generate earnings when compared with its expenses. Profitability ratios used in this study are:

$$PM(\%) = \frac{\text{net margin}}{\text{gross income}} * 100 \quad (3)$$

$$GR(\%) = \frac{\text{gross margin}}{\text{net sales}} * 100 \quad (4)$$

$$ROI = \frac{\text{gross income}}{\text{total cost}} \quad (5)$$

Where: PM= profit margin; GR= gross ratio and ROI= return on investment. Depreciation values were estimated using a straight-line method under the assumption that concrete pond and earthen pond were used for an average period of 10 and 5 years respectively and pumping machine where available for 3 years before being scrapped without salvage values. The stochastic frontier function is given as:

$\mu_i = f(Z_i; \omega)\, e^{v-u}$ (6)

The profit frontier function adopted for this study is as follows

$\pi_i = f(P_i, Z_i) \exp e_i$ (7)

$e_i = v_i - u_i$ (8)

This function can be estimated by maximum likelihood estimation (MLE) and the approach for profit function is written as:

$ln\pi_i = \beta_i + \sum \beta_i lnP_i + \beta_l lnF_j + v_i - u_i$ (9)

The frontier model is thus defined as

$ln\pi_i = \beta_0 + \beta_1 lnP_1 + \beta_2 lnP_2 + \beta_3 lnP_3 + \beta_4 lnP_4 + \beta_5 lnP_5 + \beta_6 lnP_6 + \beta_7 lnF_7 + v$ (10)

Where: π_i = profit defined as gross revenue less variable cost and fixed cost; P_1=average price of feeds; P_2=average price of fingerlings; P_3=average price of hired labour; P_4=average price of family labour; P_5=average price of lime/fertilizer; P_6=average price of other materials; F_7=average depreciation of fixed items; $\beta_0 - \beta_7$ = parameters to be estimated; V_i=error term. The profit inefficiency was modeled in terms of the socio-economic and institutional factors that were assumed to affect the profit efficiency of fish farmers. The determinants of technical inefficiency, (μ_i), are defined as:

$u_i = \omega_0 + \omega_1 Z_1 + \omega_2 Z_2 + \omega_3 Z_3 + \omega_4 Z_4 + \omega_5 Z_5 + \omega_6 Z_6 + \omega_7 Z_7 + e$ (11)

Where: U_i= technical inefficiency of the ith fish farmer; Z_1= fish farming experience (years); Z_2= level of education of fish farmer (years); Z_3= production credit (₦); Z_4 =extension contact (number of visits); Z_5 =adjusted household size; Z_6=membership in cooperative societies; Z_7=water management and Z_8=feed management. $\omega_0 - \omega_7$= parameters to be estimated and e=error term. The stochastic profit frontier function (equation 10), and the inefficiency function (equation 11) were estimated using the Frontier 4.1C computer package (Battese and Coelli, 1995). The programme combines the two-stage procedure into one and produces maximum likelihood estimates of the parameters of a stochastic profit frontier function. In addition, this does not violate the assumption that the inefficiency effects are independently and identically distributed (Battese and Coelli, 1995).

RESULTS AND DISCUSSION

Socio-economics and production data

Summary statistics of the data reported in Table 1 revealed that households' in both fish farming systems were male headed, of average productive age of 47 years and 45 years for earthen and concrete systems, respectively and have access to productive credit (₦59, 800 for earthen system and ₦67, 500 for concrete system) through their formal cooperative organizations. The result also indicated that the

sampled fish farmers in the two systems have education indices above 2015 United Nation education index of 6.5 in Nigeria. However, results reveled that investment outlay, credit access, hired labor and expenditure on feed were found to be higher in the concrete pond system compared to earthen pond system. Conversely, an area devoted to fish farming, level of fertilizer usage, number of fingerlings/juveniles stocked, experience in fish farming and family labor involvement has higher usage in earthen pond. Both earthen and concrete fish farmers lack storage and processing equipment and a handful of these respondents owned largely crude storage and processing equipment. Thus, the study revealed that the number of juveniles or fingerlings stocked per pond per fish farmer, an area devoted to farming, the level of investment, the duality of occupation or fish farming considered as secondary occupation and lack of extension contacts connotes fish farming is still not developed, subsistence and rudimentary. The findings are comparable with studies of Adebayo and Adesoji (2008), Esu *et al.* (2009), Olawumi *et al.* (2010), Olaoye *et al.* (2013) and Zacharia *et al.* (2013).

Table 1: Socio-Economics and production data of fish farmers in Kwara State, Nigeria

Description	**Earthen system**		**Concrete**	
		Mean		**Mean**
Gender	89% were male	na	75% were male	Na
Marital status	91% were married	na	70% were married	Na
Age (years)	63% above 50 years	47	59% below 50 years	45
Level of education (yrs)	52% had sec. education	9.7	59% had sec. school	10.3
Fish farm Experie. (yrs)	53% had < 10 years	11.7	62% had < 10 years	8.1
Adj. household size	58% had 5-7 persons	7	53% had <5-7 persons	6.0
No. of extension contacts	87% had no contact	na	43% had contact (s)	Na
Family labour/Lday	79% used family labor	31	38% used family labour	9
Hired labour/ prod./ Lday	43% used hired labour	14	71% used hired labour	32
Credit accessed (₦'000)	39% accessed credit	59.8	43% accessed credit	67.5
Cooperative soc. (years)	56% had about10 yrs	10	41% had about 7 years	7
No. of juveniles/pond	55% stock 5000/pond	5000	68% stock 2000/pond	2000
Feed ('₦000)	61% spent ≥ 19.7	19.7	59% spent ≥ 28.5	28.5
Lime/fertilizer uses (₦)	78% applied lime/Fert.	9760	48% do not apply either	4590
Juvenile/1000 pieces (₦)	63% preferred juvenile	25000	57% prefers fingerlings	2500
Area devoted to fish farm	63.7% devoted <0.7 ha	0.7	72% devoted< 0.2 ha	0.2
Level of invest ('₦000)	62.4% invested ≥37.4	37.4	57% invested ≥78.5	78.5
Fish income/prodn.(₦)	59% realized 144079	144079	79% realized ≥69,181	69181
Off-fish income/yrs (₦)	38% realized ≤ 144079	58900	61% realized ≤ 69,181	54760
Pond output/fish (kg)	65% harve ≥1.5kg/fish	1.35	61% harvest ≤ 1.5kg/fis	1.09
Storage and processing	90% lack the facilities	na	86% lack the facilities	na

Source: Field survey, 2015; Note: 1USD = average ₦340 in 2015, na denote not available

Profit ability analysis of earthen and concrete pond systems

The average quantity of fish sold by an earthen fish farmer at table size shown in Table 2 was 891 while losses were about 109, total revenue of ₦464, 033 per 1,000 pieces and for concrete fish farmer was 934 with losses of 66, total revenue of ₦465, 599 per 1,000 pieces. The implication of this is that losses were greater in the Earthen Pond System (EPS) than in the Concrete Pond System (CPS) as such, they (CPS) obtained higher revenue as agreeing with the study of Adeogun *et al.* (2014). The total variable cost (TVC) was ₦307, 174; gross margin and net fish income were estimated at ₦156, 859 and ₦144, 079 respectively for EPS. Total variable cost (TVC) was ₦374, 068, whilst gross margin and net fish income were estimated at ₦91, 531 and ₦69, 181 respectively for CPS. The gross and net margin analyses are further indication that fish farming is profitable in the study area. Adebayo and Adesoji (2008) and Ugwumba and Okoh (2010) reported fish farming to be profitable in their respective findings.

Profit margins were calculated at 31.04% and 14.86% for the earthen and concrete system respectively. Thus, the earthen system was found to have a higher profit margin than the concrete system, indicating

that the earthen system farmers incurred, less feed (₦186,164.0) hence low total variable cost (₦307, 174) compared to the feed cost (₦249,197) incurred by concrete system. The gross ratio of the earthen system was obtained at 33.80%, this means that the farmers still have about 34% of their sales revenue to cover their operating costs while that of the concrete system was only 19.66%, thus, the higher the gross ratio the higher the profit percentage. Return on investment (ROI) is a performance measure used to evaluate the efficiency of an investment or to compare the efficiency of different investments. ROI of EPS was 1.45. This indicated that for every ₦1.00 invested in earthen pond, there was a 45% return to profit. Whilst the ROI of the CPS was 1.17 that is for every ₦1.00 invested in concrete system, there was a 17% return to profit. Accordingly, this is an indication that the earthen system of aquaculture production is more efficient than the concrete system.

Table 2: Average Cost and Returns of Earthen and Concrete ponds per 1000 juveniles

Variables	**Earthen pond**			**Concrete pond**		
	Value (₦)	**%TVC**	**% TC**	**Value (₦)**	**%TVC**	**% TC**
a. Fixed cost						
Depreciation of fixed items	12,780			22,350		
Total Fixed Cost	12,780		4.0	22,350		5.6
b. Variable cost :						
Fingerlings	25,000	8.1	7.8	25,000	6.7	6.3
Water (imputed or calculated)	13,500	4.4	4.2	32,000	8.6	8.1
Drugs, (e.g. fungi disease, hanging)	11,580	3.8	3.6	15,730	4.2	4.0
Feed types/size/quantity/time						
10 bags of 2mm (15kg) for 2 months	49,805	16.2	15.6	87,625	23.4	22.1
5 bags of 3mm (15kg) for 1½ months	38,405	12.5	12.0	40,300	10.8	10.2
5 bags of 4mm (15kg) for 1 month	31,045	10.1	9.7	37,640	10.1	9.5
4 bags of 4.5mm (25kg) for 2 weeks	29,700	9.7	9.3	34,892	9.3	8.8
6 bags of 6mm (25kg) for 1 months	37,209	12.1	11.6	48,740	13.0	12.3
Total amount of feed	186,164	60.6	58.2	249,197	66.6	62.9
Hired labour	4,920	1.6	1.5	18,320	4.9	4.6
Family labour	20,655	6.7	6.45	11,280	3.0	2.8
Lime/Fertilizer	11,625	3.8	3.6	5,850	1.6	1.5
Harvesting	1,980	0.7	0.6	3,836	1.0	1.0
Other: (e.g. transport, security, etc.)	31,750	10.3	9.9	12,855	3.4	3.2
Total Variable Cost	307,174	100	96.0	374,068	100	94.4
c. Total Cost (a + b)	319,954	-	100	396,418		100
d. Revenue						
Quantity sold	891			934		
Loss (e.g. cannibalism, diseases, etc.)	109			66		
Average unit price	520.8			498.5		
Total Revenue	464,033			465,599		
e. Gross Margin (d-b)	156,859			91,531		
f. Net Farm Income (d-a-b)	144079			69181		
g. Profit Margin	31.04			14.86		
h. Gross Ratio	33.80			19.66		
i. Return on Investment	1.45			1.17		

Source: Field Survey, 2015 from production and financial records.

Profit efficiency analysis

Table 3 which shows the estimated profit efficiency model for both earthen and concrete systems revealed that sigma squared (σ^2) was statistically significant which shows the correctness of the specified distribution assumption of the composite error term. The gamma (γ) values for the fish farmers, which is the ratio of the variance of farm-specific profit efficiency to the total variance of profit, was 0.711 and 0.547 for EPS and CPS of fish farming respectively. This means that 71.1% (EPS) and 54.7% (CPS) of the variation in profits among the farms is due to differences in profit efficiency.

The average price of feeds was found to be positive and significant at 5% and 10% of EPS and CPS respectively. This implied that a unit increase in amount spends on feeds will give 0.407 (EPS) and 0.6220 (CPS) units increase in total profit. Furthermore, the average price of fingerlings was found to be positive and significant at 10% in EPS but not significant for CPS this implies that an increase in fingerlings will lead to 0.106 increases in output.

The average price of family labor was found to be positive and significant at 1% (EPS) while in the case of CPS hired labor was positive and significant at 5%. The positive sign implies that an increase in labor estimate by one unit will lead to an increase in profit. The result clearly shows that labor is relevant in fish production, which is in line with Adeogun *et al.* (2014) who reported that labor was positive and significant and that an increase in labor usage would result in an increase in output level of fiber pond fish farming system in Lagos State. Average depreciation of fixed items was positive and significant at 5% for CPS fish farmers only. This is an indication of that fixed factor of production in the CPS matches the portion of the profit that it generates.

The parameters estimate for determinants of profit inefficiency were also reported in Table 3. The results indicate that the profit inefficiency of EPS and CPS farmers were negatively influenced by both levels of education and feed management. In addition, fish farm experience and water management statistically influenced CPS; the negative signs in the coefficients of fish farm experience, water and feed management variables indicate a decrease in technical inefficiency or an increase in technical efficiency while the positive sign on coefficient of household size connotes a decrease in technical efficiency.

Table 3: Maximum likelihood estimates Frontier Profit Function of fish farming in Kwara State

Variables	β_i	**Earthen pond system**		**Concrete pond system**	
Profit Function		**Coefficient**	**t value**	**Coefficient**	**t value**
Constant	β_0	0.003	2.07**	0.108	1.81*
Average price of feeds	β_1	0.407	3.29***	0.620	3.95***
Average price of fingerlings	β_2	0.106	1.98*	0.400	1.14
Average price of hired labour	β_3	0.009	0.96	0.288	2.06**
Average price of family labour	β_4	0.298	2.45***	0.190	1.29
Average price of lime/fertilizer	β_5	0.177	0.79	0.008	1.04
Av. depreciation of fixed items	β_6	0.051	0.80	0.103	2.02**
Average price of other materials	β_7	0.221	0.62	0.005	0.39
Inefficiency model					
Constant	Z_0	-0.231	-1.40	0.312	2.08**
Fish farm experience	Z_1	0.099	1.32	-0.074	-1.99**
Level of education	Z_2	-0.086	-2.33**	-0.622	-3.52***
Production credit	Z_3	-0.432	-1.48	0.305	1.51
Extension contacts	Z_4	-0.062	-0.79	0.021	0.85
Adjusted household size	Z_5	0.190	2.04**	0.005	0.49
Cooperative societies	Z_6	-0.003	-0.77	0.214	1.00
Water management	Z_7	-0.308	-1.48	-0.380	-2.24**
Feed management	Z_8	-0.220	-2.39***	-0.117	-1.98*
Diagnostic Statistic					
Sigma square $\sigma^2 = \sigma_v^2 + \sigma_u^2$	σ^2	0.526	2.02**	0.499	2.18**
Gamma $\gamma = \sigma_u^2/\sigma^2$	Γ	0.711	3.08***	0.547	2.61***
Log likelihood function	*l/f*	-71		-105	
No of observation (n)		63		87	
Average Profit Efficiency		0.747		0.793	

Field survey 2015. Asterisk indicate statistically significant ***1%, **5%, *10%.

Profit efficiency

The distribution of profit efficiency of fish production (EPS) is presented in Figure 1. The profit efficiency ranged between 0.22 and 0.81 with an average of 0.747 (Table 4). The average profit efficiency score of 0.747 implies that on the average farmers could increase profits by 25.3% by means of improving their technical and allocative efficiency. Similarly, the profit efficiency distribution of fish production by the CPS is also presented in figure 1. Profit efficiency ranged between 0.32 and 0.86 with an average of 0.793 (Table 4). The average profit efficiency score of 0.793 implies that the average farm producing fish could increase profits by 20.7% via improving their technical and allocative efficiency.

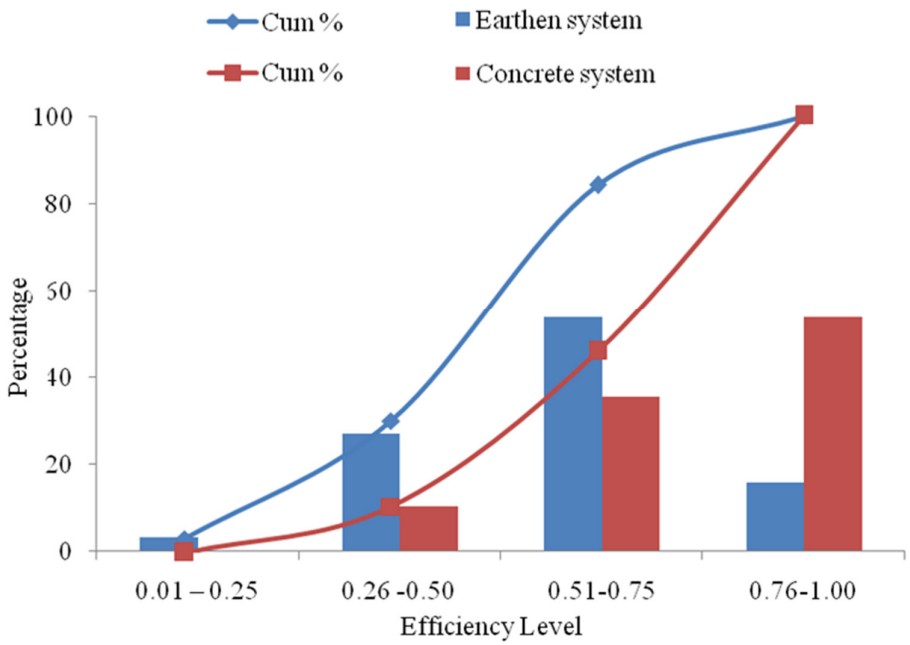


Fig. 1: Quartiles frequency distribution of profit efficiencies of the two fish farming Systems

Table 4: Profit Efficiency parameters

Efficiency parameters	Earthen pond	Concrete pond
Minimum	0.22	0.32
Maximum	0.81	0.86
Mean	0.747	0.793
Number of observation	63	
t-test	2.09**	

Field survey, 2015; ** denote significant at 5% level of probability

Determinants of profit loss

The socioeconomic factors contributing to profit loss by the system are presented in Table 5. Profit loss is considered here as the difference between maximum profit and actual profit given prices and fixed factor endowments. For farmers who did not go to school, profit loss was statistically significant at 1%, and ranged from ₦55, 255 to ₦42, 306 for EPS and CPS respectively. In the four categories ranging from no education to tertiary education, higher levels of education were associated with smaller profit losses in each of the systems. Education also translated into efficiency gains. For example, EPS fish farmers who had no education were only 57% efficient, while those with education had the following efficiency levels: primary (60%), secondary (76.8%), and tertiary (74%).

Access to extension services also reduced profit losses in the farming systems. Generally, farmers receiving extension services experienced efficiency improvements of 5.7% points, from 72.4 to 78.1% for ES and 7.1 % points from 76.4 to 83.5% in CPS. Access to credit reduced profit loss for all systems.

For farmers with access to credit, profit losses ranged from ₦32, 554 to ₦30, 002 for both EPS and CPS correspondingly. These findings suggest that having access to credit improves profit efficiency from 62.2 to 78.8% for ES and 77.4 to 81.7% in the study area.

The result further showed that there is a significant relationship between experience and loss of profit at the 5 % level of probability. This implies that fish farmers with more years of experience exhibited significantly lesser loss of profit than farmers with less years of experience in both systems. Farms with high investment exhibited a significantly ($p<0.05$) higher profit less than farms with low investments in the ES ₦43, 742 and ₦39, 545 for high and low investments respectively. In contrast, low investment farms had higher losses than high investments in the CPS.

Table 5: Profit loss in two different fish farming production by Socioeconomic Characteristics

Variables	Earthen pond system				Concrete pond system			
	N	Actual profit (₦)	Profit loss (₦)	E scores (%)	N	Actual profit (₦)	Profit loss (₦)	Ef.(%) scores
Education								
None [a] ***	8	128,340	55,255	57.0	12	131,432	42,306	67.8
Primary [b]	19	134,508	53,950	60.0	13	137,885	39,750	71.2
Secondary [c]	33	157,520	36,540	76.8	51	143,244	38,605	73.0
Tertiary [d]	3	137600	34,800	74.7	11	141,596	23,389	83.5
Extension								
No access [a]	55	137,542	37,905	72.4	49	138,005	32.544	76.4
Access [b] **	8	159,327	34,850	78.1	38	157,238	26.004	83.5
Credit								
No access	38	129,458	48,910	62.2	50	135,994	30,674	77.4
Access*	25	152,793	32,554	78.7	37	164,228	30,002	81.7
Experience								
< 5 years**	33	131,249	42,654	67.5	15	120,206	47,904	60.1
5-10 years	17	147,328	37,644	74.4	39	139,653	29,996	78.5
> 10 years	13	142,558	33,615	76.4	33	154,660	26,001	83.2
Investment								
Low	44	133,744	39,545	70.4	48	134,518	31,639	76.5
High**	19	168,366	43,742	74.0	39	169,806	28,003	83.5

Field survey 2015. n = number of observations, Ef. = efficiency; Asterisk indicate significance ***1%,**5%, *10%.

Low investments had a profit, loss of ₦31, 639 and N28, 003 for high investment and this could be as a result that the latter has wherewithal to make inputs available to reduce shock and losses. The result is comparable with Oladimeji *et al.* (2015) findings on profit loss due to variance in socioeconomic factors among motorized and non-motorized fisherfolks in North Central Nigeria.

Conclusion and recommendations

This study has revealed that fish farming in EPS and CPS was profitable, but farmers do not operate on the profit frontier. Major causes of inefficiency are low levels of education and limited access to extension services. Farmers with no education experienced the highest loss of profit as compared to those with education. Access to extension services enhances profitability, and those who did not have access experienced greater profit loss. Another factor reducing efficiency is limited access to credit.

Aquaculture business is viable in Nigeria from all indications but needs more efforts from both the public and government to increase its local production so as to bridge the gap between the fish demand and its supply in the country hence protein self-sufficiency. Standards for the development of aquaculture are not beyond the country's potentials. There is, therefore, need for education and training for all fish farming communities. Furthermore, more resources should be devoted to the fish farming extension so as to encourage proper aquaculture system design, good stocking and water quality management to allow farmers to produce on or close to the frontier level. Fish farmers should strive to

optimize efficient use of resources, practice earthen and concrete fish farming to increase output and profit as well as to ensure market and price advantages. Ultimately, this will be an impetus to achieving sustainable fish production and improve living standard among fish farming households in the studied areas. It is also recommended that fish farming households should form a formidable social organization to benefit from the economy of bulk purchase of fish input supply, fish farm advisory services, increased access to micro-credit, and access to modern fish pond techniques. Finally, funding of relevant research institutes (e. g. Nigerian Institute for Oceanography and Marine Research (NIOMR), the Lake Chad Research Institute (LCRI), National Institute for Freshwater Fisheries Research, New Bussa, and the Fisheries Departments in some tertiary institutions) to carry out investigations and studies that could enhance fish production in the country.

Acknowledgements

The authors are grateful to Eng. Ayodele Akano of Kwara State Polytechnic, Ilorin and Yunusa O. Adisa, Dept. of Biological Sciences, Ahmadu Bello University, Zaria for their immense assistance during the preliminary stage of this work and field surveys. To my employer, Ahmadu Bello University, for providing an enabling environment for all my research work.

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