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African Crariid Catfish Farming in Concrete and Earthen Ponds: A Comparative Profitability Analysis

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Abstract: The study compared the profitability and returns to scale of African Clariid catfish farming using concrete and earthen ponds in Anambra State, Nigeria. Primary data were obtained from useful copies of questionnaire returned by 204 out of the 256 respondents interviewed for the study. Data were analyzed by means of budgetary method, translog stochastic frontier models and a 4-point Likert scale. Mean net farm income and net return on investment values were N593,314 and 0.56 for the concrete pond farms and N1,122, 586 and 0.75 for the earthen pond farms. This implies that catfish production using either the concrete or earthen pond type of production unit is profitable. Returns to scale values were 2.46 and 0.69 for the concrete and earthen ponds, respectively, an indication of increasing and decreasing returns to scale. Catfish production was seriously constrained by high cost of feeds, lack of capital and scarcity of seeds. The earthen ponds were more profitable than the concrete ponds, however the concrete ponds were in the majority (77%; n = 158). Policy must be channeled towards measures that would ameliorate production problems and encourage the setting up of concrete ponds. Such measures should include the establishment of modern feed mill and hatcheries; the broadening of extension services and the provision of credit facilities.

Key words: Comparative profitability, budgetary technique, econometrics, concrete and earthen ponds, African Clariid catfish, Nigeria

INTRODUCTION

Aquaculture is the production of animals such as fish, turtle, shrimps, lobsters, crabs and crops such as rice and seaweeds (Nwuba and Onuoha, 2006). It is therefore, the culture of aquatic plants and animals (FAO, 2003). Fish farming is part of aquaculture but sometimes the two words are used interchangeably because majority of output from aquacultural production comes from fish farming. Fish farming/culture is the growing of fish in a controlled environment which could be ponds (concrete or earthen), vats (wooden or fibre glass) and plastics (Osawe, 2004; Nwokoye *et al.*, 2007).

According to Olagunju *et al.* (2007), fish farming started in Nigeria about 50 years ago with the establishment of a small experimental station at Onikan, Lagos state and an industrial farm about 20 ha at Panyam in Plateau State by the Federal Government of Nigeria. Presently, the culture of fish has spread to all states of the federation. Fish culture has been established as the best alternative to bridging the widening gap between the demand for and supply of food fish in the country. This will save the country huge foreign exchange of about N50 billion expended to import close to 700,000 metric tons of food fish annually to cushon the effect of inadequate local supply. Among the culturable species of food fish in Nigeria (carp, tilapia and catfish), catfish is the most sought after specie, very popular with fish farmers and commands a very good commercial value in Nigerian markets (Samson, 1997). Consequently, the catfish is very important to the sustainability of the aquaculture industry in the country having possessed the following good qualities identified by Adediran (2002) and Osawe (2004) as hardy; survives in different culture systems and diverse environments; grows very fast has higher fecundity; improved survival of the fry and adaptation to supplemental feed. Studies conducted by Olagunju *et al.* (2007) and Kudi *et al.* (2008) and a few others have attested to the profitability of catfish production. However, this profitability is still being weighed down by constraints such as the use of poor quality catfish seeds, inadequate information, high cost of feeds, traditional

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techniques, small size of holdings, poor infrastructural facilities and low capital investment (Adeogun *et al*., 2007; Ugwumba and Nnabuife, 2008). The study specifically examined the profitability of catfish production using concrete and earthen ponds, elasticity and returns to scale and constraints to production in the study area.

MATERIALS AND METHODS

Anambra state is one of the 36 states of the Federal Republic of Nigeria (2006). It is composed of 21 Local Government Areas (LGAs) and 4 agricultural zones. The population stands at over 4 million as at 2006 national population census. It occupies an area of 4,416 km^2, 70% of which is arable land.

The state is situated on a fairly flat land with tropical vegetation. The climate is humid with substantial rainfall and mean temperature of 87°F. It has a weak soil that is easily eroded, thus accounting for over 500 erosion sites of varying depth and length. Agriculture is the predominant occupation in the rural areas engaging >70% of the rural population. Crop and livestock farming are traditional while fish farming is gaining grounds (Ugwumba, 2005).

A multistage random sampling technique was used to select 256 catfish farmers for the study, however, 204 of them returned useful copies of questionnaire. The multistage random sampling method involved sampling 8 LGAs out of the remaining 15 LGAs, 4 communities from each of the 8 LGAs and then 8 farmers from each of the 4 communities to arrive at the 256 respondents. Data collection was through primary sources using interview instruments, observations and respondent's memory recall. Data collection was for a production period of 12 months and in this case January to December, 2009. Data were collected on input and output variables, their prices and constraints to production. Data were analyzed by means of enterprise budgeting technique, translog stochastic frontier production function and a 4 point Likert scale. The enterprise budgeting technique used to assess the profitability of the catfish farming enterprise is shown as:

$$GM = TR\text{-}TVC$$

$$NFI = GM\text{-}TFC \text{ or } TR\text{-}TC$$

$$NROI = NFI/TC$$

Where:

GM = Gross margin
TR = Total revenue
TVC = Total variable cost
NFI = Net farm income
TC = Total cost
TFC = Total fixed cost
NROI = Net return on investment

The output elasticities with respect to the inputs, X_i for the translog production function was calculated by mean differencing all the variables (output and inputs variables) before estimation (Coelli *et al*., 1998). With this, the elasticities for the four inputs were the coefficients of the direct Cobb-Douglas terms, X_1, X_2, X_3 and X_4 (i.e., farm size, labour, capital and feeds, respectively) in the mean differenced translog equation and the returns to scale coefficient was the sum of the elasticities of the inputs. The respective output elasticity equations for the four inputs are shown as:

$$\xi Q_{fs} = \frac{\partial \ln Q}{\partial \ln Fs} = \beta_{fs} + 2\psi_{fs}\ln(Fs) + \psi_{lfs}\ln(L) + \psi_{cfs}\ln(C) + \psi_{ffs}\ln(F)$$

$$\xi Q_{l} = \frac{\partial \ln Q}{\partial \ln L} = \beta_{l} + 2\psi_{l}\ln(L) + \psi_{fsl}\ln(Fs) + \psi_{cl}\ln(C) + \psi_{fl}\ln(F)$$

$$\xi Q_{c} = \frac{\partial \ln Q}{\partial \ln C} = \beta_{c} + 2\psi_{c}\ln(C) + \psi_{fsc}\ln(F) + \psi_{lc}\ln(L) + \psi_{fc}\ln(F)$$

$$\xi Q_{f} = \frac{\partial \ln Q}{\partial \ln F} = \beta_{f} + 2\psi_{f}\ln(F) + \psi_{fsf}\ln(Fs) + \psi_{lf}\ln(L) + \psi_{cf}\ln(C)$$

Where ξQ_{fs}, ξQ_l, ξQ_c and ξQ_f are the elasticities of output with respect to farm size, labour, capital and feed, respectively. Returns to Scale (RTS) is the sum of individual elasticity values of the independent variables and it is represented as:

$$RTS = \xi Q_{fs} + \xi Q_{l} + \xi Q_{c} + \xi Q_{f}$$

A 4-point Likert scale was deployed in determining the degree of seriousness of production constraints. The scale employs an ordinal level of measurement. The responses from the respondents were ranked in a sort of dimension or disaggregated along a continuum. The response indicating the most serious constrain was given the highest score. Responses on constraints to catfish production were disaggregated as follows:

- Very serious = 4
- Serious = 3
- Moderately serious = 2
- Not serious = 1

Determination of cut-off point;

$$\bar{X} = \frac{\sum f}{n} = \frac{4+3+2+1}{4} = \frac{10}{4} = 2.50$$

Where:

$\bar{X}$ = Critical mean score
f = Total scale score (i.e., 4, 3, 2, 1)
n = Scale points

To make inferential statement, the mean score is compared with the critical mean, 2.50. If the calculated mean of a problem is greater than the standard critical value then that problem is regarded as very serious. The equation used to determine variable mean score is shown as:

$$\bar{X}_i = \frac{\sum f}{n}$$

Where:

$\bar{X}_i$ = Variable mean score
I = Variables (e.g., problems 1, 2, ………., 11 of catfish production)
$\sum f$ = Total scores of all the respondents on a variable
n = Number of respondents

RESULTS AND DISCUSSION

Profitability of catfish production in concrete and earthen ponds: The estimated profitability of catfish production in concrete and earthen ponds in the study area using enterprise budgetary technique and net return on investment is as shown in Table 1. Results of the analysis showed that the respective Mean Net Farm Income (MNFI) and Net Return on Investment (NROI) figures were ₦594,314 and 0.56 for the concrete pond farms and ₦1,122,586 and 0.75 for the earthen pond farms. This implies that the earthen ponds returned on the average 19 kobo higher than the concrete ponds for every 100 kobo investment. By these results, catfish production in the study area using either the concrete or earthen pond production unit is a profitable venture. However, it could be observed that the earthen ponds were more profitable than their concrete pond mates going by higher values of MNFI and NROI recorded by them. The outcome of this analysis is surprising because the concrete ponds were preferred by majority of the farmers (77%; n = 158) contrary to the 23% of the farmers who used the earthen ponds (n = 46). The reason could be that some of the concrete pond farms performed poorly to have impacted negatively on profit. On the other hand, better performance of the earthen ponds could be attributed to the reasons reported by (Nwuba and Onuoha, 2006; Ugwumba, 2010) that the earthen ponds provide catfish with natural environment devoid of noise and endowed with natural water filtering agents and natural feed items (such as phytoplanktons, zooplanktons, snails, worms, clay for calcium, etc.) which encourage faster growth of fish. This situation, in addition to proportionately lower stocking density, bigger water volume and larger farm size, opined by Ugwumba (2010) might have contributed to better performance of the earthen ponds.

According to Zen *et al.* (2002), technical efficiency of production is sometimes better explained by output elasticities of production inputs and returns to scale. The result of analysis of output elasticities of catfish production inputs (i.e., farm size, labour, capital and feed) is shown in Table 2. The result indicated returns to scale values of 2.46 and 0.69 for the concrete and earthen ponds, respectively. This means that the concrete ponds were operating at increasing returns to scale and the earthen ponds at decreasing returns to scale. It also implies that the concrete and earthen pond farms are at stages 1 and 3 of the traditional production function, respectively. The concrete pond farms should continue to increase their output by employing more inputs while holding the fixed input level steady. However, caution must be exercised with the use of the labour input which had negative sign and was being over utilized. This result corroborates Zen *et al.* (2002) who reported over utilization of the labour input in their study on technical efficiency of driftnet and payang seine fisheries in West Sumatra, Indonesia.

Table 1: Estimated profit for catfish production in concrete and earthen ponds (₦)

Variables	Concrete pond farms (n = 158)	Earthen pond farms (n = 46)
Total revenue	260,997,850	120,815,500
TVC	183,803,675	68,100,195
GM	77,194,175	52,715,305
TFC	3,450,515	1,076,347
TC (TVC+TFC)	167,254,190	69,176,542
NFI (GM-TFC)	93,743,660	51,638,958
Mean NFI:	593,314	1,122,586
NROI(NFI/TC)	0.56	0.75

Field survey, 2009

Table 2: Estimated translog output elasticities and returns to scale for concrete and earthen ponds

Farm groups	Variables	Coefficient	T-statistic
Concrete	Blnfarm size	0.28	0.28 ns
Ponds	Blnlabour	0.55	0.54 ns
	Blincapital	-0.03	0.02 ns
	Blinfeed	1.66	1.66*
	RTS	2.46 increasing	
Earthen	Blnfarm size	0.55	0.55 ns
Ponds	Blnlabour	0.68	0.68 ns
	Blncapital	0.26	0.26 ns
	Blnfeed	-0.81	0.81 ns
	RTS	0.69 decreasing	

Field survey, 2009. RTS: Returns To Scale. NS: Not Significant. *: Significant at 10% level of probability

Table 3: Problems of catfish production

Problems	Calculated mean	Rank
High cost of feed	3.850*	1st
Lack of capital	3.180*	2nd
Scarcity of seeds	2.950*	3rd
Lack of modern technologies	2.250	4th
High cost of transportation	2.110	5th
High cost of labour	2.060	6th
Lack of land	1.940	7th
Poaching	1.190	8th
Inadequate water supply	1.764	9th
Mortality of fish	1.759	10th
Poor storage facilities	1.330	11th

Field survey, 2009

On the contrary, the earthen pond farms having decreasing returns to scale should scale down their operations in order to maintain their profit status. They should do so by reducing their inputs use especially the feed input with negatively signed coefficient, an indication of over utilization. The earthen pond farmers over utilized their feed input probably because of the earlier reported reason of their being richly endowed with natural feed items above the farmer's expectations and calculations.

Constraints to catfish production: The productivity of catfish farmers in the study area was constrained by several factors. The top in rank among these problems as shown in Table 3 was high cost of feed (3.85) followed by lack of capital (3.18) and scarcity of seed (2.95). Other constraints not asterisked which were below the critical mean of 2.50 thatis lack of modern technology (2.25), high cost of transportation (2.11), high cost of labour (2.06), lack of land (1.94), poaching (1.90), inadequate water supply (1.764), mortality of fish (1.759) were perceived as moderately serious problems. However, poor storage facilities (1.33) posed no problem to catfish farming.

CONCLUSION

Catfish production in the study area using either the concrete or earthen pond production unit is a profitable enterprise. The use of any of the pond types yielded positive mean net farm income and net return on investment. However, the earthen pond farmers realized higher profit than their concrete pond counterparts and therefore returned 19 kobo higher on every 100 kobo invested in the business. The concrete pond farms were operating at increasing returns to scale and are at stage 1 of the traditional production function, while the earthen pond farms were at stage 3 having exhibited attributes of decreasing returns to scale. The earthen pond farmers should reduce their inputs usage especially the feeds input in order to earn better profit.

The concrete pond farms were equally profitable and in the majority. This is an evidence that they can be established on any size and type of land. Catfish production was seriously constrained by high cost of feed, lack of capital and scarcity of quality seeds. Policy must be directed toward measures that would ensure amelioration of the production problems and the establishment of concrete ponds to create more employment opportunities. Such measures should include the setting up of modern feed mills, hatcheries and the broadening of extension services and access to credits.

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